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MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

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NEW AND INTERESTING POLYPORES FROM MEXICO

by

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SUMMARY

Forty three species of polypores from Mexico studied by the authors since 1989 are discussed, of which 19 are new records for the Mexican mycoflora and 23 are reported from new localities. Most of the studied specimens are from tropical vegetation, except a few from temperate regions or from coniferous forests. The studied species are reported from the following states of the country: Baja California, Distrito Federal, Jalisco, Morelos, Quintana Roo, Veracruz and Yucatan.

RESUMEN

Se discuten 43 especies de Poliporáceos de México estudiadas por los autores desde 1989, de las cuales 19 son nuevos registros para la micoflora mexicana y 23 se presentan de nuevas localidades. La mayoría de los especímenes proceden de vegetación tropical, excepto unos pocos que son de zonas templadas o de bosques de coníferas. Las especies consideradas se adscriben a las entidades federativas: Baja California, Distrito Federal, Jalisco, Morelos, Quintana Roo, Veracruz y Yucatán.

INTRODUCTION

The polypores of Mexico have been studied during the last century, through the works of Kickx (1841) to Saccardo (1888), and in the present centuary through several contributions by Murrill (Murrill, 1905, 1907-1908, 1912, 1915), and modern revisions of Anell and Guzmán (1988), Ojeda-López *et al.* (1986), Valenzuela and Nava (1991), Valenzuela and Chacón-Jiménez (1991) and Vázquez and Guzmán-Dávalos (1991). Nevertheless the knowledge of the group is still scanty, as shown by the revision on some collections in XAL Herbarium. Among these the authors found 19 new records for the country, and 23 from new localities not only from the tropics where the mycological studies are few but also from temperate regions, where the mycology has a good development.

The present paper is based on the study of more than 70 specimens of polypores of XAL Herbarium (mostly duplicates from ENCB), with duplicates in O. All the material was studied by the authors between 1989-1991. The nomenclature following in this paper, in according to Gilbertson and Ryvarden (1986-1987).

CONSIDERED SPECIES

A total of 43 species of polypores were studied, of which 19 are new records from Mexico, and 23 are reported from new localities. Tables 1 and 2 show the studied species. ***Phylloporia spathulata*** is considered in connection with a discussion of ***P. veraecrucis*** from a new locality.

Albatrellus subrubescens (Murr.) Pouz.

This is an unusual North American species, only known from Arizona and Florida in the U.S.A., and recently reported from Mexico, from the States of Michoacan (Díaz-Barriga *et al.*, 1988) and Chiapas, Mexico, Nuevo Leon and Veracruz (Valenzuela & Nava, 1991). The studied material is characterized by the basidiocarps with yellowish, smooth to squamulose pileus, pore surface greenish yellow with irregular reddish-orange tints, context cream colored and unchanging, and by the absence of clamp connections and amyloid spores.

Material studied. STATE OF VERACRUZ, Region E of Cofre de Perote, S of Tembladeras, El Revolcadero, *Pinus* forests, **Villarreal 1424**.

Amauroderma camerarium (Berk.) Furt.

It is a widespread fungus in the neotropics (Furtado, 1981), and recognized by its pale yellowish context. Welden *et al.* (1979) and Anell & Guzmán (1987, 1988), reported this fungus from the State of Veracruz.

Material studied. STATE OF QUINTANA ROO, road to the sea from the road Puerto Morelos to Tulum, near the deviation to Vallarta, tropical forest, **López 1848**.

Amylosporus campbellii (Berk.) Ryv.

This is a new record from Mexico. It is a pantropical species; in America known from southern United States, besides of Bermuda (Gilbertson & Ryvarden, 1986-1987), and the Caribbean zone. Murrill (1915) described this species as ***Tyromyces graminicola*** Murr. Usually the species grows in clusters of semistipitate to fanshaped basidiocarps on the ground in subtropical or tropical vegetation. The pileus is whitish to pale brownish, grayish brown or cinnamon brown, irregularly and finely tomentose. The poroid surface is almost concolorous with the pileus. Microscopically the small warted and strongly amyloid spores are characteristic and point to relationships with the Hericiaceae where these features are common.

Material studied. STATE OF MORELOS, road Cuernavaca to Cuautla, Cañon de Lobos, km 14, tropical forest, **Guzmán 6777**.

Anomoporia albolutescens (Rom.) Pouzar

This is a temperate species, known from Europe and North America through the coniferous forests (Gilbertson & Ryvarden, 1986-1987). The Mexican collection is the first record to Mexico. The thin resupinate, loosely attached, rhizomorphic and pale yellowish, yellow or orange yellowish basidiocarps are typical in this fungus. Welden *et al.* (1979) reported ***A. myceliosa*** (Peck) Pouzar (as ***Poria myceliosa*** Peck) from Acayucan, Ver. a species with white basidiocarp.

Material studied. STATE OF VERACRUZ, Region E of Cofre de Perote, S of Tembladeras, El Revolcadero, *Pinus* forest, **Montoya 318**.

Antrodia gossypina (Speg.) Ryv.

A new record from Mexico. This species has a wide distribution in temperate zones, mostly in coniferous forests (Gilbertson & Ryvarden, 1986-1987). It is recognized by its resupinate thick, soft to cottony, white to whitish or whitish rose basidiocarp, with a rhizomorphic margin and by the ellipsoid spores, 4.5-6 x 2-3 μm.

Material studied. STATE OF VERACRUZ, Municipio de Totula, El Mirador, subtropical forest with *Quercus*, **Ventura 16294**.

Antrodia malicola (Berk. & Curt.) Donk

This species was known from Mexico (as ***Trametes malicola*** Berk. & Curt.) from a report by Sharp (1948), without specific locality. It is widespread in warmer or temperate zones, common in North America, but rare in Europe and Africa. The basidiocarps are resupinate, effused-reflexed or sessile, forming nodulose to imbricate pilei, whitish or pale woody color, with tomentose to agglutinated glabrous surface .

Material studied. STATE OF VERACRUZ, Los Tuxtlas Region, near El Jical, tropical forest, **Guzmán 19702**.

Antrodia vaillantii (Fr.) Ryv.

Lowe (1966) reported this species as ***Poria vaillantii*** (Fr.) Lowe from Mexico, but without specific locality. It is a widespread and conspicuous crusty fungus, very close to ***A. gossypina*** (see that). Many reports of this fungus are based on sterile specimens having a well developed rhizomorphic margin, common also in that species. ***A. vaillantii*** has spores (5-8 x 3-4 μm) larger than ***A. gossypina***.

Material studied. STATE OF YUCATAN, between Xkantam and Progreso, plantation of henequen (***Agave fourcroydes*** Lem.), **Guzmán 21365**.

Antrodiella angulatopora Ryv.

This species was recently described from Venezuela (Ryvarden, 1987), and this is the second report of the fungus. The basidiocarp is sessile, broadly attached, imbricate and semicircular; the upper surface is whitish to ochraceous with narrow orangish yellow zones, and the pore surface is pale yellowish in dry conditions.

Material studied. STATE OF VERACRUZ, road Xalapa to

Tlapacoyan, near Atzalan, La Calavera, subtropical forest with *Quercus* and *Cyathea*, **Ventura 12958**.

Antrodiella versicutis (Berk. & Curtis) Gilbn. & Ryv.

This is a neotropical fungus, first reported from Mexico. The allantoid spores separate this species from others of the genus. The studied specimens have sessile basidiocarps or short or long stipitate, fanshaped pileus with the upper surface glabrous, ochraceous to whitish yellow; pore surface almost concolorous with the pileus, pores 6-8 per mm. Murrill (1907-1908) described this species as ***Coriolus ochrotinctellus*** Murr. It is very interesting to observe the apparently abundance of ***A. versicutis*** in the tropical vegetation of the eastern part of Peninsula of Yucatan, and the absence of records from other tropical regions of Mexico, which suggest that this is a Caribbean and South American species, as those discussed by Guzmán (1986).

Material studied. STATE OF QUINTANA ROO, road Felipe Carrillo Puerto to Vigia Chico, 20 km from Felipe Carrillo Puerto, tropical forest, **Guzmán 20777**. Road Puerto Morelos to Tulum, near the deviation to Vallarta, tropical forest, **Guzmán 23830**; **López 1815**; **1882**. Road Coba to Nueva Xcan, near the deviation to Sajaca-Chen, tropical forest, **López 1925**. N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23853**.

Aurificaria luteo-umbrina (Rom.) Reid

Murrill (1907-1908) described this species as ***Pyroporellus subblinteus*** Murr. from Mexico (from the coasts of the State of Sonora). ***A. luteo-umbrina*** is common in America, from the SE of the U.S.A. to Brazil, and in Australia, but unknown from Africa (Ryvarden & Johansen, 1980; Gilbertson & Ryvarden, 1986-1987). The basidiocarps are sessile on logs, rusty to yellowish brown and brittle, up to 80 mm wide; the context is bright yellowish brown, instantaneously staining red with KOH; the pore surface turns brownish red or cinnamon brown when touch in fresh conditions. The lack of setae and the globose to subglobose spores, that stain olivaceous brown in KOH define the species.

Material studied. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23862**.

Coriolopsis floccosa (Jungh.) Ryv.

This species was reported by Ojeda-López *et al.* (1986) from the State of Guanajuato. It is a pantropical fungus, apparently more common in the old tropics than in the neotropics. The basidiocarps are sessile, broadly attached and semicircular, with brown to grayish pileus, with black concentric zones in dry specimens. It may be confused with ***C. rigida*** (see that); however this latter species is more thinner and flexible, and with pale brown pore surface.

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Tulum, near the deviation to Vallarta, tropical forest, **Guzmán 23950**.

Coriolopsis rigida (Berk. & Mont.) Murr.

Murrill (1907-1908, 1912), Welden & Lemke (1961), Castillo *et al.* (1969), Castillo & Guzmán (1970), Guzmán (1972) and Anell & Guzmán (1987) reported this species from the State of Nuevo Leon, Colima and Veracruz. This is a very common fungus in the neotropics, but it is widespread even in the Eastern U.S.A. The basidiocarp is variable in habit, from effused or connate to imbricate clusters (see discussion of ***C. floccosa***).

Material studied. STATE OF YUCATAN, 5 km S of Xochel, road to Huhi, near Sacabah, tropical forest, **Guzmán 23746**.

Daedalea microsticta Cooke Figs. 4-5

This is a widespread neotropical fungus. It was known from the States of Colima and Veracruz (Murrill, 1912; Guzmán, 1972, Anell & Guzmán, 1987). Here it is recorded from the States of Nuevo Leon and Quintana Roo. The basidiocarp is applanate, more or less thick, sessile, light color; the pileus is ivory color in dry conditions, and reach more than 120 mm wide. Some studied specimens were found in ENCB as ***Daedalea elegans*** Spreng. : Fr., a neotropical fungus widespread in Mexico, that differs from ***D. microsticta*** for its white funnel shapped basidiocarp with a thin pileus.

Material studied. STATE OF NUEVO LEON, Municipio Santiago, La Chancaca, **Castillo 211**; El Cercado, **Sepulveda 19**; **Ramírez s.n.,** all in subtropical forests. STATE OF QUINTANA ROO, road Vigia Chico to Felipe Carrillo Puerto, Rancho Yaras, tropical forest, **Guzmán 23934**.

Datronia caperata (Berk.) Ryv.

A pantropical species reported from Mexico as ***Polyporus caperatus*** Berk., ***Coriolopsis caperata*** (Berk.) Murr., and ***C. caperatiformis*** Murr., from the States of Campeche, Colima, Hidalgo, Quintana Roo, Tabasco and Veracruz by Murrill (1912, 1915), Guzmán (1972, 1975), Welden *et al.* (1979), and Anell & Guzmán (1987). The sessile, thin and flexible basidiocarp is very variable in form, from applanate, dimidiate, conchate to flabelliform, up to 50 mm wide. In wet and shady places the pileus becomes almost smooth with a tomentum restricted only to certain zones, but in drier and sunny localities, it is covered with a characteristic dark tomentum in distinct zones and below the tomentum there are well defined black zones. The pore surface is white, but in old and dried specimens is pale brownish, grayish brown to deep brown; in fresh conditions turns brown when touched.

Material studied. STATE OF MORELOS, highway Mexico to Cuernavaca, near the deviation to Cuautla, subtropical forest with *Quercus*, **Guzmán 18114**. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23869**.

Diplomitoporus lenis (Karst.) Gilbn. & Ryv.

A new report from Mexico, this is a common circumglobal species in subtropical and temperate areas (Gilbertson & Ryvarden, 1986-1987), but rare in the tropics. Ryvarden and Johansen (1980) reported only one specimen from Africa [as ***Antrodia lenis*** (Karst) Ryv.]. The spores are small, allantoid to lunate and the basidiocarp is resupinate, white to whitish, forming large crusts under the logs.

Material studied. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23871**.

Flavodon flavus (Kl.) Ryv.

This species has hitherto not been reported from America. It is very common in Africa, Asia and Australia (Ryvarden & Johansen, 1980) and otherwise shows the relationships between tropical regions of Mexico and Africa, observed by Guzmán *et al.* (1989). The intense yellow to orangish yellow basidiocarps are very conspicuous. The hymenophore is hydnoid to iripiciform and the pileus turns red with KOH.

Material studied. STATE OF QUINTANA ROO, road Coba to Nueva Xcan, near the deviation to Sajaca-chen, **López, 1941**; **1947**.

Fomitopsis melliae (Underw.) Gilbn. & Ryv. Fig. 2

It is a new report from Mexico. This is a North American species (Gilbertson & Ryvarden, 1986-1987), and the collections from Mexico represent the southern limit so far known today. The basidiocarp is up to 80 mm wide, thin to thick, sessile with a pileus surface ivory to tan or cinereous color, frequently glabrous and azonate (the collection from Quintana Roo is faintly zonate and thin); the pore surface is whitish to ochraceous and the context is whitish to pale buff.

Material studied. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Chuyaxchen, Archeological zone of Mugil, tropical forest, **Guzmán 24147**. STATE OF VERACRUZ, N of Xalapa, Rancho Lucas Martín, subtropical disturbed vegetation, **Guzmán 1915** (this specimen was reported by Guzmán, 1963-A, as ***Daedalea ambigua*** Berk.).

Ganoderma coffeatum (Berk.) Furt. Figs. 6-7

This species also placed in ***Amauroderma*** by Murrill or ***Humphreya*** by Steyaert (1972), was recently reported from Mexico by Cappello & Hernández (1990), Vázquez & Guzmán-Dávalos (1991) and Valenzuela & Chacón-Jiménez (1991) from the States of Jalisco, Tabasco and Tamaulipas. It is a neotropical and widespread fungus, very common in South America. Its light colored context, the brown ferrugineous velutinous pileus and stipe, the whitish pore surface and the coarsely ornamented spores with a prominent reticulated pattern of coherent ridges, are distinct good features of this species. Macroscopically this fungus resembles an ***Amauroderma***. Here it is reported for first time from the States of Quintana Roo and Veracruz.

Material Studied. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23902**. STATE OF VERACRUZ, Uxpanapa region, tropical rain forest, **Guzmán 30467**.

Grammothele fuligo (B. & Br.) Ryv.

This is a tropical corticoid fungus, reported as ***Porogramme fuligo*** (B. & Br.) Pat. by Lowe (1963) from Mexico without specifing locality. The species occurs exclusively on dead leaves or stems of monocotyledoneous, specially on all types of palms. It is easy to overloook due to its resupinate basidiocarp with dark gray bluish paints.

Material studied. STATE OF QUINTANA ROO, road to Xcan, 15 km from Coba, tropical forest, **López 1913**.

Incrustoporia nivea (Jungh.) Ryv.

This is a circumglobal temperate species. It was reported from Mexico by Sharp (1948) as ***Polyporus semipileatus*** Peck, without specifing locality. Murrill (1912) reported it from the State of Morelos as ***Tyromyces semipileatus*** (Peck) Murr. It is known in North America as ***Skeletocutis nivea*** (Jungh.) Keller (Gilbertson & Ryvarden, 1986-1987). It presents white to cream color annual basidiocarp, effused-reflexed to resupinate.

Material studied. STATE OF BAJA CALIFORNIA, road Ensenada to Ojos Negros, NE of Agua Viva, *Quercus* forest, **Guzmán 24302-A**.

Inonotus hispidus (Bull. : Fr.) Karst.

This is a common fungus in the United States (Gilbertson & Ryvarden, 1986-1987), characterized by its strongly hispid upper surface and the pigmented spores. The species was known from Mexico from the States of Baja California, Hidalgo, Mexico, Michoacan, Nuevo Leon and Veracruz (Bandala *et al.*, 1992). In the present paper it is reported from Jalisco.

Material studied. STATE OF JALISCO, 11 km NE of Tamazula, Rio Contla, tropical disturbed vegetation, **Guzmán 8593**.

Inonotus munzii (Lloyd) Gilbn.

A subtropical to xerophitic warm temperate American fungus, easy to recognize from the other species of the genus by the branched setigerous elements of the pileus and lack of setae. The basidiocarps are sessile, frequently ungulate and bright yellowish brown to reddish brown or cinnamon brown. The species was first reported from Mexico by Guzmán (1963-A, -B) in subdesert lands from the north to the central regions of the country. Castillo & Guzmán (1970) reported it from the State of Nuevo Leon. It is reported here for first time from Distrito Federal.

Material studied. DISTRITO FEDERAL, Mexico City, Santo Tomas Colonia, Campus of the National School of Biological Sciences, on a living ***Schinus molle*** L., **Fanti 74**.

Junghuhnia nitida (Pers. : Fr.) Ryv.

This species was reported from the State of Oaxaca by Welden *et al.* (1979). It is a cosmopolitan fungus, recorded from Northern Norway to Australia and New Zealand. It grows on any type of dead wood of angiosperms. Curiously in Mexico it is only known from tropical regions. The pinkish-cinnamon color of the pore surface and the so common thick-walled incrusted cystidia are characteristic features of this species (Gilbertson & Ryvarden, 1986-1987).

Material studied. STATE OF QUINTANA ROO, near the road Puerto Morelos to Felipe Carrillo Puerto, Archeological zone of Chunyaxché, tropical forest, **Guzmán 20646**. STATE OF VERACRUZ, Los Tuxtlas Region, 3 km S of Montepio, tropical rain forest, **Guzmán 7257**.

Microporellus obovatus (Jungh.) Ryv.

This is a pantropical species reported from Mexico by Cappello & Hernández (1990), Vázquez & Guzmán-Dávalos (1991) and Valenzuela & Chacón-Jiménez (1991) from the States of Jalisco, Tabasco and Tamaulipas. The white to yellowish orange or straw color, tomentose to velvety striate, round to reniform or spathulate pileus, sometimes radially striate, laterally stipitate, with a white to concolorous pore surface and with very small pores (6-8 per mm) are features that distinguish this peculiar species (Gilbertson & Ryvarden, 1986-1987).

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Vallarta, San Matilde, tropical forest, **Guzmán 20539**. State of Veracruz, Municipio de Totutla, El Mirador, subtropical forest, **Ventura 17324**. Los Tuxtlas Region, 7 km S of Montepio, Biological Station of the University of Mexico, tropical rain forest, **Guzmán 7160**. 2 km SW of Xalapa, near Rio Coapexpan, subtropical forest with *Quercus* and *Liquidambar*, **Bandala 227**.

Oligoporus fragilis (Fr.) Gilbn. & Ryv.

A new report for the State of Morelos. This species was only known from the States of Guanajuato and Michoacan (Cifuentes *et al.*, 1990; Ojeda-López *et al.*, 1986) [in both cases as ***Tyromyces fragilis*** (Fr.) Donk]. It is a boreal fungus following pine trees in high altitudes. It is easy to recognize by the white to buff basidiocarps that turn reddish brown when bruised or dried.

Material studied. STATE OF MORELOS, Lagunas de Zempoala National Park, near the principal lagoon, *Pinus* forest, **Guzmán 3174**.

Perenniporia ohiensis (Berk.) Ryv.

Welden & Lemke (1961) and Castillo *et al.*, (1969) reported this fungus as ***Fomes ohiensis*** (Berk.) Murr. from the State of Nuevo Leon. The large (up to 13 μm long) thick-walled, dextrinoid spores are the principal features of this American species, as well as its small effused-reflexed or ungulate basidiocarps, with pileus whitish or ivory to brown or blackish, glabrous and azonate or fairy zonate, and almost concolorous with the pore surface and context (Gilbertson & Ryvarden, 1986-1987).

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Tulum, near the deviation to Vallarta, Botanical Garden of CIQRO, tropical vegetation, **Guzmán 23788**. N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mogil, tropical forest, **Guzmán 23872**. STATE OF YUCATAN, 5 km S of Xocchel road to Hohi, near Sacabah, tropical forest, **Guzmán 23753**. 5 km S of Conkal, road to Telchac, tropical forest, **Guzmán 23595**.

Perenniporia tephropora (Mont.) Ryv.

A new record from Mexico. It is a pantropical species, known in the State of Louisiana (U.S.A.), the Caribbean region and Africa (Gilbertson & Ryvarden, 1986-1987; Ryvarden & Johansen, 1980), and considered as ***Loweporus*** by Ryvarden or ***Fomitopsis cubensis*** by Murrill. It is characterized by its basidiocarps, which are resupinate, large and thick, crustose and perennial, grayish to dark ochraceous or milk coffee color to ferrugineous brown. The basidiocarps frequently grow on vertical surfaces of the trunks.

Material studied. STATE OF YUCATAN, road Merida to Valladolid, 3 km from Tixpeual, tropical forest, **Guzmán 23636**.

Phellinus chryseus (Lév.) Ryv.

A new record from Mexico. It is a rare neotropical species, originally described from Colombia (Ryvarden, 1981; Ryvarden & Johansen, 1980). The fairly large setae and small hyaline dropshaped basidiospores, define the species, besides its typical brown ferrugineous context and pore surface, as well as the rimose and zonate grayish black pileus. The Mexican collection represents the northern limit so far known to this fungus. The studied specimen was growing in a disturbed tropical vegetation.

Material studied, STATE OF JALISCO, Tamazula region, near Agua Caliente, tropical deciduous forest, **Guzmán 12486**.

Phellinus contiguus (Fr.) Pat.

It is a widespread species in the tropics and warmer parts of Europe (Gilbertson & Ryvarden, 1986-1987). The large hyaline and ellipsoid spores and tramal setae characterize the species. The basidiocarp is perennial and resupinate, forming a thick, rusty brown crust below the logs. It is reported for first time from Mexico from tropical forests of the Peninsula of Yucatan.

Material studied. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23882**.

Phellinus ferrugineo-velutinus (Henn.) Ryv.

This is a rare resupinate neotropical species, new recorded from Mexico, and characterized by small hyaline spores and scattered setae (Gilbertson & Ryvarden, 1986-1987). Probably overlooked as other resupinate ***Phellinus*** species, which are often neglected because of the considerable difficculties presented in their identification. ***Ph. ferrugineo-velutinus*** forms large and thick, ferrugineous brown crusts under the logs, with a conspicous mustard yellow color margin.

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Tulum, near the deviation to Vallarta, road to the sea, tropical forest, **López 1849**.

Phellinus grenadensis (Murr.) Ryv.

New record from Mexico. It is a wide-spread species in the Caribbean zone and Central America. It belongs to the complex group of pileate species without setae and rather uniformely ellipsoid spores (Gilbertson & Ryvarden, 1986-1987). The studied specimen has a small basidiocarp, no more than 20 mm wide, subungulate, rusty brown and with a crustose pileus.

Material studied. STATE OF QUINTANA ROO, Municipio Lázaro Cárdenas, S of Chinquilla, tropical disturbed vegetation in a grassland, **Guzmán 20657**.

Phellinus rhytiphloeus (Mont.) Ryv.

This is a rare tropical species, previously known only from

Brazil (Ryvarden & Johansen, 1980). It has solitary, dimidiate, thick, applanate and semicircular basidiocarps, with the typical brown cinnamon color. When cut it presents a distinct black line below the pileus. It is reported for first time from Mexico.

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Tulum, near Puerto Morelos, tropical forest, **López 1319**.

Phellinus rimosus (Berk.) Pilát Fig. 1

This is a complex species with a widespread distribution in the tropical and subtropical regions of the world. It grows in Africa (Ryvarden & Johansen, 1980), but its presense in the U.S.A. is doubtful (Gilbertson & Ryvarden, 1987). It was reported from Mexico as *Fomes*, Cooke, from several temperate and subtropical localities (Bandala *et al.*, 1992). It is reported here for first time from Yucatan. The perennial, ungulate basidiocarp, with brownish to blackish and tomentose to rimose pileus, yellowish-brown pore surface and lack of setae are characteristic in this species.

Material studied. STATE OF YUCATAN, Municipio Progreso, between Chelen and Chuburna, tropical vegetation, **Guzmán 21373-B**.

Phylloporia chrysita (Berk.) Ryv.

A pantropical species, recorded from Mexico from the State of Tamaulipas (Valenzuela & Chacón-Jiménez, 1991) and from the Uxpana region in the State of Veracruz (Welden *et al.*, (1979). In the presented paper it is reported from a new locality from the State of Veracruz. The sessile, thick, rusty-brown basidiocarps, with the pileus covered by a thick and velvety spongy compressed tomentum, as well as the thin context separated by a dark line from the tomentum, are good features that define the fungus and separate it from ***Ph. frutica*** (Berk. & Curt.) Ryv., also known from Mexico as parasitic on several tropical trees (Guzmán, 1977).

Material studied. STATE OF VERACRUZ, Municipio Minatitlán, Rio Coachapa, El Remolino, tropical forest, **Pérez Ortíz 894**.

Phylloporia spathulata (Hook.) Ryv.

It is a pantropical species, known as ***Polyporus*** by Cooke, ***Coltricia*** by Murrill and ***Polystictus*** s. auct., rather common although often overlooked due to its small size and dark brown color basidiocarps, growing on the ground often among leaves and debris inside the tropical forests. It seems to be a parasitic fungus, at least specimens from Colombia were attached to living roots, and others from Mexico present a long pseudorrhiza.

This fungus was reported from Mexico from the States of Quintana Roo and Yucatán by Guzmán (1983) and from Veracruz by Guzmán and Guzmán-Dávalos (1984). The species is considered here, in spite of that the studied material is from the same above regions of the country, because it is closely related to ***Ph. veraecrucis*** (see below), which was considered as synonym, and actually as an independent species; both species have golden-yellow to cinnamon brown stipitated basidiocarps. ***Ph. spathulata*** has pileus 10-60 mm broad and spores 3-4 x 2-3 μm, while ***Ph. veraecrucis*** presents pileus up to 100 mm wide and spores 4-4.5 x 3-3.5 μm, as shown in the study of the type at K.

Material studied. STATE OF QUINTANA ROO, road Escarcega to Chetumal, 10 km N from Tomas Garrido, **Guzmán 20910**; **23884**. Road Puerto Morelos to Tulum, near the deviation to Vallarta, **Guzmán 21003**; **21065**; **23958**; **López 1826**; **1831**. STATE OF YUCATAN, road Merida to Valladolid, between Ticopo and Tahnek, **Guzmán 23680**. 5 km S of Xocchel, near Sacabah, **Guzmán 23694**; **23710** (all the collections from tropical forests).

Phylloporia veraecrucis (Berk. ex Sacc.) Ryv.

This is an interesting fungus described as ***Polyporus veraecrucis*** Berk. from the State of Veracruz in the last century (Berkeley, 1867), based in a collection on roots of a tropical tree in 1854. It was validated and redescribed by Saccardo (1888). Murrill (1905) studied the type at K and considered the species as ***Phaeolopsis veraecrucis*** (Berk.) Murr. Ryvarden & Johansen (1980) considered ***Ph. veraecrucis*** as synonym of ***Ph. spathulata*** (see that), but recently, Ryvarden (1991) recognized this species and presented a modern description based on a study of the type. In the present paper this fungus is reported for the first time from the State of Quintana Roo.

Material studied. STATE OF QUINTANA ROO, Cozumel region, Coba, tropical rain forest **Guzmán 20729.**

Piptoporus soloniensis (Dub. : Fr.) Pil.

A new record from Mexico. This is a rare species distributed in the SW of the United States (Gilbertson & Ryvarden, 1986-1987). The Mexican collection seems to be the southern limit in the continent. The basidiocarp is similar to ***Laetiporus sulphureus***

(Bull. : Fr.) Murr. (***Polyporus pseudosulphureus*** Long is a synonym of ***P. soloniensis***), but the discussed species has not the bright orange and yellow sulphur coloration. The clamp connections in the generative hyphae are a distinct feature.

Material studied. STATE OF VERACRUZ, road Xalapa to Tlapacoyan, Municipio Atzalan, La Calavera, subtropical forest with *Quercus*, **Ventura 17315** (Anell & Guzmán, 1988, reported this specimen as ***Laetiporus sulphureus***).

Polyporus varius Fr.

A circumglobal fungus specially common in temperate zones, but scattered in the tropics (Ryvarden & Johansen, 1980, did not report this species from Africa). The stipitate light coloured basidiocarps with a black stipe make it rather distinct in the genus except for ***P. elegans*** Bull. : Fr., that differs in the lack of the striations of the pileus. The young specimens present light coloured basal stipe as most of the studied specimens. This species has been recorded from the States of Chiapas, Michoacan, Mexico Tamaulipas and Veracruz (Bandala *et al.*, 1992). Here it is reported for first time from Morelos, Quintana Roo and Yucatan.

Material studied. STATE OF MORELOS, IV Mushroom Exposition of Morelos, **Guzmán 21911**. STATE OF QUINTANA ROO, N of Reserva de la Biósfera de Sialan Kalan, Archeological zone of Mugil, tropical forest, **Guzmán 23873**. Road Puerto Morelos to Tulum, near the deviation to Vallarta, tropical forest, **Guzmán 21015**; **21077**. STATE OF YUCATAN, 5 km S of Xocchel, road to Huhi, near Sacabah, tropical forest **Guzmán 23687**.

Rigidoporus vinctus (Berk.) Ryv. var. ***cinerea*** (Bres.) Setliff.

A new record from Mexico. The variety ***vinctus*** was reported from different localities in the State of Veracruz (Lowe, 1963, Guzmán, 1972, Welden *et al.*, 1979, Anell & Guzmán, 1987) as ***Poria vincta*** (Berk.) Curt. (except in the last reference, where it was cited as ***Rigidoporus***). The var. ***cinerea*** differs from the typic by the grey to dark brown to almost black pore surface (pale ochraceous buff to light pinkish ochraceous in the latter), and by the perennial widely effused or effused-reflexed basidiocarp, with pores 6-12 per mm.

Material studied. STATE OF QUINTANA ROO, 20 km from Felipe Carrillo Puerto, road to Vigia Chico, tropical forest, **Guzmán 20773-B**.

Trichaptum biforme (Fr.) Ryv. Fig. 3

A very common fungus in Mexico in temperate and tropical regions, frequently reported as ***Polyporus pargamenus*** Fr. (Guzmán, 1977). It is closely related with ***Trichaptum abietinus*** (Dicks. : Fr.) Ryv. from which differs mainly in the more purplish bluing color of the pore surface and larger basidiocarps. ***T. biforme*** is reported here for first time from the State of Quintana Roo.

Material studied. STATE OF QUINTANA ROO, road Puerto Morelos to Tulum, near the deviation to Vallarta, road to the sea, tropical forest, **López 1830**. STATE OF VERACRUZ, Uxpanapa region, tropical rain forest, **Guzmán 30466**.

Tyromyces fumidiceps Atk.

This species was known only from Eastern U.S.A. and Canada (Gilbertson & Ryvarden, 1987). The light greenish color of the pore surface in herbarium specimens is characteristic. The Mexican material has laterally stipitate basidiocarp, and whitish to brownish yellow or brown chocolate color, azonate and tomentose pileus. Its habitat is always close to stream and rivers, where the basidiocarps are found on drift wood and similar debris.

Material studied. STATE OF MORELOS, old road Mexico City to Cuernavaca, 3 km S of Tres Marias, Colonia Atlixtac, near a river, *Pinus-Quercus* forest with subtropical elements, **Guzmán 8474**.

Tyromyces galactinus (Berk.) Lowe

A new record from Mexico. This common North American species (Gilbertson & Ryvarden, 1986-1987) is recognized by its soft, white to whitish gray or pale ochraceous, strigose to tomentose basidiocarps, with duplex context and fragant odour. The studied specimen presents imbricate basidiocarps growing on a living trunk of ***Platanus lindeniana*** Mart. & Gal.

Material studied. STATE OF VERACRUZ, old road Xalapa to Coatepec, deviation to Rancho Guadalupe, way to Instituto de Ecología, subtropical (mesophitic) disturbed forest, **Bandala-Muñoz 233**.

Tyromyces humeana (Murr.) Lowe

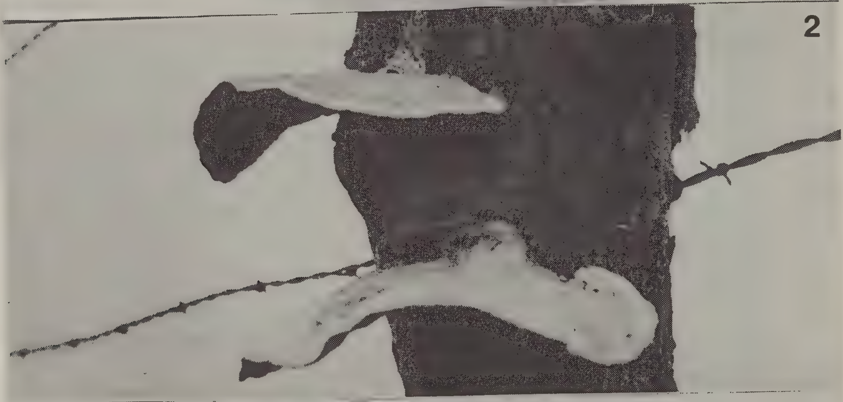
The species was only known from the type locality in Florida (U.S.A) (Gilbertson & Ryvarden, 1986-1987). The Mexican collection agrees well with Murrill's fungus, except by the anise odour in fresh basidiocarps which was not indicated in the studied specimens. The basidiocarp is white but in dry condition turns brownish even cinnamon brown in the center of the pileus.

Material studied. STATE OF MORELOS, road El Parque to Tepoztlan, near Tepozteco mountain, subtropical forest, **Guzmán 5451**.

Table 1. Polypores new from Mexico

Amylosporus campbellii (Berk.) Ryv.
Anomoporia albolutescens (Rom.) Pouzar
Antrodia gossypina (Speg.) Ryv.
Antrodiella angulatopora Ryv.
A. versicutis (B. & C.) Gilbn. & Ryv.
Diplomitoporus lenis (Karst.) Gilbn. & Ryv.
Flavodon flavus (Kl.) Ryv.
Fomitopsis meliae (Underw.) Gilbn. & Ryv.
Perenniporia tephropora (Mont.) Ryv.
Phellinus chryseus (Lév.) Ryv.
Ph. contiguus (Fr.) Pat.
Ph. ferrugineo-velutinus (Henn.) Ryv.
Ph. grenadensis (Murr.) Ryv.
Ph. rhytiphloeus (Mont.) Ryv.
Piptoporus soloniensis (Dub. : Fr.) Pil.
Rigidoporus vinctus var. ***cinerea*** (Bres.) Setliff.
Tyromyces fumidiceps Atk.
T. galactinus (Berk.) Lowe
T. humeana (Murr.) Lowe

1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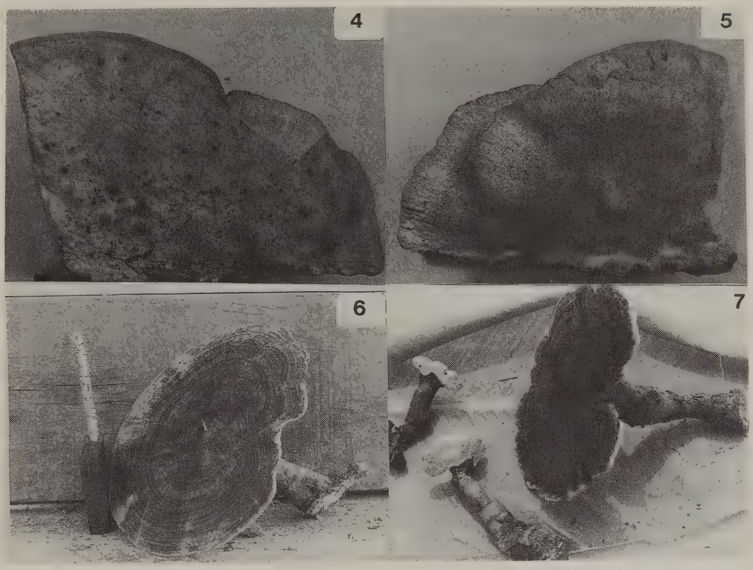

Figs. 1-3.- 1: ***Phellinus gilvus*** (Kruse, s.n., from Guerrero). 2: ***Fomitopsis melliae*** (Guzmán 1915, from Veracruz). 3: ***Trichaptum biforme*** (Guzmán 30466 from Veracruz).

Figs. 4-7.-4-5: ***Daedalea microsticta*** (Sepúlveda 19, from Nuevo Leon). 6-7: ***Ganoderma coffeatum*** (Guzmán 30467, from Veracruz).

Table 2. Polypores from new localities in Mexico

Albatrellus subrubescens (Murr.) Pouz.
Amauroderma camerarium (Berk.) Furt.
Antrodia malicola (B. & C.) Donk
A. vaillantii (Fr.) Ryv.
Aurificaria luteo-umbrina (Rom.) Reid
Coriolopsis floccosa (Jungh.) Ryv.
C. rigida (Berk. & Mont.) Murr.
Daedalea microsticta Cooke
Datronia caperata (Berk.) Ryv.
Ganoderma coffeatum (Berk.) Furt.
Grammothele fuligo (B. & Br.) Ryv.
Incrustoporia nivea (Jungh.) Ryv.
Inonotus hispidus (Bull. : Fr.) Karst.
I. munzii (Lloyd) Gilbn.
Junghuhnia nitida (Pers. : Fr.) Ryv.
Microporellus obovatus (Jungh.) Ryv.
Oligoporus fragilis (Fr.) Gilbn. & Ryv.
Perenniporia ohiensis (Berk.) Ryv.
Phellinus rimosus (Berk.) Pilát.
Phylloporia chrysita (Berk.) Ryv.
Ph. veraecrucis (Berk. ex Sacc.) Ryv.
Polyporus varius Fr.
Trichaptum biforme (Fr.) Ryv.

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LITERATURE CITED

Anell, J.C. and G. Guzmán, 1987. Especies de Poliporáceos citadas del Estado de Veracruz. *Rev. Mex. Mic. 3* : 137-148.

Anell, J.C. and G. Guzmán, 1988. Nuevos registros de los hongos del grupo de los Poliporáceos del Estado de Veracruz. *Rev. Mex. Mic. 4* : 25-42.

Bandala, V.M., G. Guzmán and L. Montoya, 1992. *Los hongos del grupo de los Poliporáceos conocidos en México.* Universidad Autónoma de Nuevo León, Linares (en prensa).

Berkeley, M.J., 1867. On some new fungi from Mexico. *Linn. Soc. Jour. (Bot.) 9* : 423-425.

Cappello, S. and H. Hernández, 1990. Lista preliminar de los hongos (macromicetos) y mixomycetes de Tabasco, México. *Universidad y Ciencia 7 (13)* : 15-21.

Castillo, J. and G. Guzmán, 1970. Estudios sobre los Poliporáceos de Nuevo León, II. *Bol. Soc. Bot. Mex. 31* : 1-47.

Castillo, J., G. Guzmán and G. Sepulveda, 1969. Estudios sobre los Poliporáceos de Nuevo León. I. *Ciencia, Mex. 27* : 9-18.

Cifuentes, J., M. Villegas, L. Pérez-Ramírez, M. Bulnes, V. Corona, M. del R. González, I. Jiménez, A. Pompa and G. Vargas, 1990. Observaciones sobre la distribución, hábitat e importancia de los hongos de Los Azufres, Michoacán. *Rev. Mex. Mic. 6* : 133-149.

Díaz-Barriga, H., F. Guevara-Fefer and R. Valenzuela, 1988. Contribución al conocimiento de los macromicetos del Estado de Michoacán. *Acta Botánica Mex. 2* : 21-44.

Furtado, J.S., 1981. Taxonomy of ***Amauroderma*** (Basidiomycetes, Polyporaceae). *Mem. N.Y. Bot. Gard. 34* : 1-109.

Gilbertson, R.L. and L. Ryvarden, 1986-1987. *North American Polypores.* Fungiflora, Oslo (vols. 1 & 2).

Guzmán, G., 1963-A. Frecuencia y distribución de algunos Basidiomycetes lignícolas importantes en México. *An. Esc. Nac. Cienc. Biols. 12* : 23-41.

Guzmán, G., 1963-B. Macromicetos de las zonas áridas de México, I. *An. Esc. Nac. Cienc. Biols. 12:* 43-60.

Guzmán, G., 1972. Macromicetos mexicanos en el Herbario The National Fungus Collections de E.U.A. *Bol. Soc. Bot. Mex. 32* : 31-55.

Guzmán, G., 1975. Hongos mexicanos (macromicetos) en los herbarios del extranjero III. *Bol. Soc. Mex. Mic. 9* : 85-102.

Guzmán, G., 1977. *Identificación de los hongos.* Ed. Limusa, Mexico City.

Guzmán, G., 1983. Los hongos de la Península de Yucatán, II. Nuevas exploraciones y adiciones micológicas. *Biotica 8* : 71-100.

Guzmán, G., 1986. Distribución de los hongos en la región del Caribe y zonas vecinas. *Caldasia 15* : 103-120.

Guzmán, G., V.M. Bandala, L. Montoya and Y. Saldarriaga, 1989. Nuevas adiciones sobre las relaciones micoflorísticas entre Africa y el neotrópico. El género *Rugosospora* Heinem. (Fungi, Agaricales). *Brenesia 32* : 107-112.

Guzmán, G. and L. Guzmán-Dávalos, 1984. Nuevos registros de hongos en el Estado de Veracruz. *Bol. Soc. Mex. Mic. 19* : 221-244.

Kickx, J., 1841. Notice sur quelques champignons du Mexique. *Bull. Acad. Sc. Brux. 8* : 72-81.

Lowe, J.L., 1963. A synopsis of ***Poria*** and similar fungi from the tropical regions of the world. *Mycologia 55* : 453-486.

Lowe, J.L., 1966. *Polyporaceae of North America. The genus* ***Poria***. State Univ. College of Forestry, Syracuse University, Tech. Publ. 90, Syracuse.

Murrill, W.A., 1905. The Polyporaceae of North America. XII. A synopsis of the white and bright-colored pileate species. *Bull. Torrey Bot. Club. 32* : 469-493.

Murrill, W.A., 1907-1908. Polyporaceae. *In: North American Flora 9.* N.Y. Bot. Garden, New York.

Murrill, W.A., 1912. The Polyporaceae of Mexico. *Bull. New York Bot. Gard. 8 (28)* : 137-153.

Murrill, W.A., 1915. *Tropical Polypores.* Lancaster, New York.

Ojeda-López, S., M. Sandoval and R. Valenzuela, 1986. Los Poliporáceos de México. I. Descripción de algunas especies del noreste de Guanajuato. *Rev. Mex. Mic. 2* : 367-436.

Ryvarden, L., 1981. Type studies in the Polyporaceae 13. Speccies described by J.H. Léveillé. *Mycotaxon 13:* 175-186.

Ryvarden, L., 1987. New and interesting polypores from tropical America. *Mycotaxon 28:* 525-541.

Ryvarden, L., 1991. *Genera of Polypores. Nomenclature and Taxonomy.* Synopsis Fungorum 5, Fungiflora, Oslo.

Ryvarden, L. and I. Johansen, 1980. *A preliminary polypore flora of East Africa.* Fungiflora, Oslo.

Saccardo, P.A., 1888. *Sylloge Fungorum.* Vol. 6 (Reprint 1944, Edwards Brothers, Ann Arbor).

Sharp, A.J., 1948. Some fungi common to the highlands of Mexico, Guatemala and Eastern United States. *Mycologia 52* : 856-876.

Steyaert, R.L., 1972. Species of the ***Ganoderma*** and related genera mainly of the Bogar and Leiden Herbaria. *Persoonia 7* : 55-118.

Valenzuela, R. and R. Nava, 1991. *El género Albatrellus (Polyporaceae) en México.* Memorias IV Congreso Nacional de Micología, Tlaxcala.

Valenzuela, R. and S. Chacón-Jiménez, 1991. Los Poliporáceos de México. III. Algunas especies de la Reserva de la Biósfera El Cielo, Tamaulipas. *Rev. Mex. Mic. 7* : 39-70.

Vázquez, L.S. and L. Guzmán-Dávalos, 1991. Nuevos registros de Poliporáceos estipitados de Jalisco. *Rev. Mex. Mic. 7* : 113-120.

Welden, A.L., L. Dávalos and G. Guzmán, 1979. Segunda lista de los hongos, líquenes y mixomicetos de las regiones de Uxpanapa, Coatzacoalcos, Los Tuxtlas, Papaloapan y Xalapa (México). *Bol. Soc. Mex. Mic. 13* : 151-161.

Welden, A.L. and P.A. Lemke, 1961. Notas sobre algunos hongos mexicanos. *Bol. Soc. Bot. Mex. 26* : 1-24.

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GLOMALES OF TAIWAN:
III. A COMPARATIVE STUDY OF SPORE ONTOGENY IN SCLEROCYSTIS (GLOMACEAE, GLOMALES)[1]

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KEY WORDS: *Sclerocystis*, sporophore, sporocarp formation, spore germination, spore ontogeny.

ABSTRACT

During the course of investigation on the Glomales of Taiwan, numerous sporocarps of *Sclerocystis* were isolated and identified as *S. coremioides*, *S. clavispora*, *S. sinuosa*, *S. rubiformis*, *S. taiwanensis*, and *S. liquidambaris*. After detailed comparison among these species by optical and electron microscopy, the similarity of spore ontogeny and spore arrangement in sporocarps was determined. Chlamydospores of *S. coremioides* with long, slender subtending hyphae also produced sporophores the same as those of other species of *Sclerocystis* and *Glomus*. The chlamydospores of *S. coremioides* are not always occluded by septa. The suggestion to define *Sclerocystis* as a monotypic genus is rejected. A modified generic concept and a hypothesis to explain sporocarpic evolution of *Sclerocystis* are proposed.

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INTRODUCTION

Glomus and *Sclerocystis* were considered as closely related groups and *Sclerocystis* appeared to be evolutionarily advanced in sporocarp morphology from *Glomus* (Gerdemann and Trappe, 1974). Recently, Almeida and Schenck (1990) proposed to transfer most of the species of *Sclerocystis* to *Glomus* and retained only *S. coremioides* Berk. and Br. in the genus, because there were at least four uniquely different features in *S. coremioides*, *i.e.* (i) each spore forms individually on a subtending hypha without branching to form a sporophore near the spore base, (ii) spores have a well-defined septum, (iii) spores are arranged in a hemispherical layer, and (iv) sporocarps form distally or laterally from the older sporocarps and appear fused in a column or branch. Almeida and Schenck (1990) concluded that these characters were not found in other species of *Sclerocystis* and *Glomus*. They applied Madelin's (1970) mode of sympodial conidial formation to distinguish spore ontogeny of *Glomus* from *Sclerocystis*, and postulated that *S. rubiformis* Gerdemann and Trappe (1974), *S. clavispora* Trappe (1977), *S. sinuosa* Gerdemann and Bakshi (1980), *S. taiwanensis* Wu and Chen (1987), and *S. liquidambaris* Wu and Chen (1987) should be transferred to *Glomus*. They have the same type of spore ontogeny as found in *G. ambisporum* Smith and Schenck, *G. heterosporum* Smith and Schenck (Smith and Schenck, 1985), and other species of *Glomus*. *Glomus* species have the ability to generate a lateral sporophore in the subtending hypha near the spore base.

During the survey of Glomales of Taiwan, abundant sporocarps of *Sclerocystis* were collected from a variety of sites. These materials provided all of the presently described species of *Sclerocystis* and were very beneficial to the taxonomic study. In this paper, new evidence of spore ontogeny and sporocarp formation, a modified generic concept of *Sclerocystis*, and a hypothesis of sporocarpic evolution are presented.

MATERIAL EXAMINATIONS

Sporocarps were isolated by a wet-sieving and decanting (Gerdemann and Nicolson, 1963) and were observed by optical and scanning electron microscopy. In order to observe the central plexus of sporocarps, fruiting bodies were ultrasonicated to break down peridial tissues and chlamydospores.

The following specimens were examined:

Sclerocystis clavispora-TAIWAN: Chi-tou, from rhizosphere of *Chimonobambusa quadrangularis* (Fenzi) Markino, Wu-850821; Chi-tou, from the rhizosphere of *Erechthites valerianifolia* (Wolf) DC., Wu-8508201; Chi-tou, from the rhizosphere of *Gingo biloba* L., Wu-8508202; Chi-tou, from the rhizosphere of *Colocasia formosanum* Hayata, Wu-8607151; Kenting, from the rhizosphere of *Colocasia formosanum*, Wu-8605171; Pintong, from the rhizosphere of asparagus (*Asparagus officinalis* L.), Wu-860813.

Sclerocystis coremioides-TAIWAN: Tainan, from rhizosphere of *Ageratum conyzoides* L., Wu-850725; Tainan, from the rhizosphere of orange (*Citrus sinensis* Osb.), Wu-8608141; Taipei, from the rhizosphere of *Bignonia* sp., Wu-850810; Chi-tou, from the rhizosphere of *Colocasia formosanum*, Wu-8607152; Pintong, from the rhizosphere of asparagus (*A. officinalis*), Wu-860813; USA: Oregon, F55365.

Sclerocystis liquidambaris-TAIWAN:Taipei, Holotype, from rhizosphere of *Liquidambar formosana* Hance, Wu-860203; Isotype, Wu-860627; Kaoshiun, Liou-Kuei, from the rhizosphere of *Cunninghamia lanceolata* (Lamb.) Hook, Wu-870117.

Sclerocystis rubiformis-TAIWAN: Chi-tou, from the rhizosphere of *Erechthites valerianifolia*, Wu-8508203; Chi-tou, from the rhizosphere of *Gingo biloba*, Wu-8508204; Chi-tou, from the rhizosphere of *Colocasia formosanum*, Wu-8607153; Kenting, from the rhizosphere of *Colocasia formosanum*, Wu-8605172.

·***Sclerocystis sinuosa***-TAIWAN: Tainan, Anpin; from the rhizosphere of *Miscanthus* sp. in *Casuarina equisetiffolia* L . woods, July 25, 1985, Wu-850725; Tainan, Anpin, from the rhizosphere of ground covers in *C. equisetifolia* woods, September 18, 1985, Wu-850918; Pintong, by Kau-ping River, from the rhizosphere of legume (*Glysine* sp.), August 14, 1986, Wu-8608142; Pintong, by Kau-ping River; from the rhizosphere of asparagus (*A. officinalis*), August 13, 1986, Wu-860813; Pintong, Tongang, from the rhizosphere of unidentified herb grass, August 13, 1986, Wu-ME2; Tainan, Charlu, from the rhizosphere of citrus (*Citrus* sp.), August 14, 1986, Wu-8608143; Nantou, Chi-tou, from the rhizosphere of *Sinocalamus* sp., August 21, 1985, Wu-8508144; Taichung, Wu-feng, from the rhizosphre of maize

(*Zea mays* L.), November 14, 1991, Wu-111401; Orchid Island, Taitung, from the rhizosphere of *C. equisetifolia*, July 7, 1986, WU-860707; U.S.A., INVAM collection, Gainesville, Florida (SSNS 122).

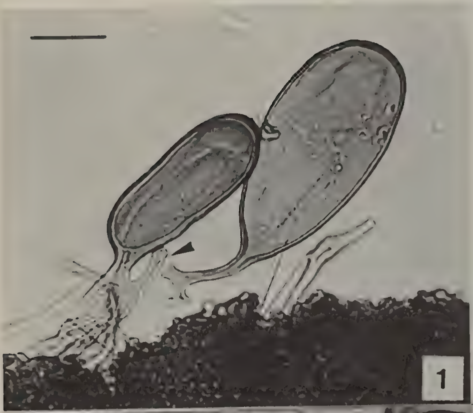
Sclerocystis taiwanensis-TAIWAN:Chi-tou, Holotype, from the rhizosphere of *Crassocephalum rabens* (Juss. ex Jacq.) S. Moore, Wu-8508205; Chi-tou, from the rhizosphere of *Colocasia formosanum*, Wu-8607154; Taipei, from the rhizosphere of unknown host, Wu-850810; Tainan, from the rhizosphere of orange (*C. sinensis*), Wu-850724.

RESULTS

SPOROPHORE OF *SCLEROCYSTIS*: Sporophores branching from the base of chlamydospore are very commonly found in the every species of *Sclerocystis*. The sporophores are of various shapes such as membraneous vesicles (Figs. 1, 3, 4), dichotomous branches (Figs. 2, 6), or irregular forms. Sporophores are not uncommon in *S. coremioides*. They may be globular structures or tubular hyphal branches (Figs. 4, 7). The formation of sporophores is by branching from the chlamydospores with or without septa. Sporophores of *S. liquidambaris* are further differentiated into clubshaped structures which are parts of the peridium (Figs. 2, 9).

SEPTA OF CHLAMYDOSPORES: Septa are very often formed at the bases of chlamydospores in *Sclerocystis* (Figs. 3, 4). The frequency of septa depends on the species and represents one of character in the species description. The septum is very commonly, but not always, found below the base of chlamydospores in *S. coremioides* (Figs. 4, 7). A

Figures. 1-6. Micrographs of *Sclerocystis* spp. Fig. 1. Chlamydospores of *S. sinuosa* with a sporophore (arrow head). Fig. 2. Chlamydospores of *S. liquidambaris* with a sporophore (arrow head). Note paraphysis-like structures (P) enclosing the chlamydospore. Fig. 3. Chlamydospores of *S. taiwanensis* with sporophores (arrow head). Note the septa formed at the bases of spores. Fig. 4. A sporophore of *S. coremioides* formed below the spore base (arrow head). Note the presence of a membraneous septum (arrow) at the spore base. Fig. 5. Mature (upper) and vesicular young spores (YS) of *S. clavispora*. Note the mature spore enclosed by a exospore wall (arrows). Fig. 6. Hyphal branches formed from the spore base of *S. clavispora*. Scale= 30 µm.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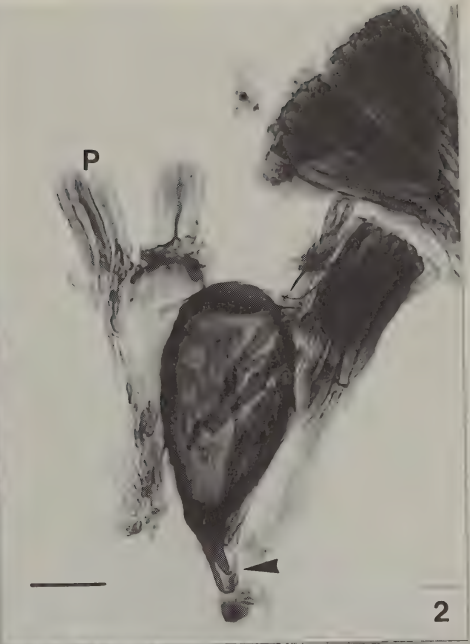
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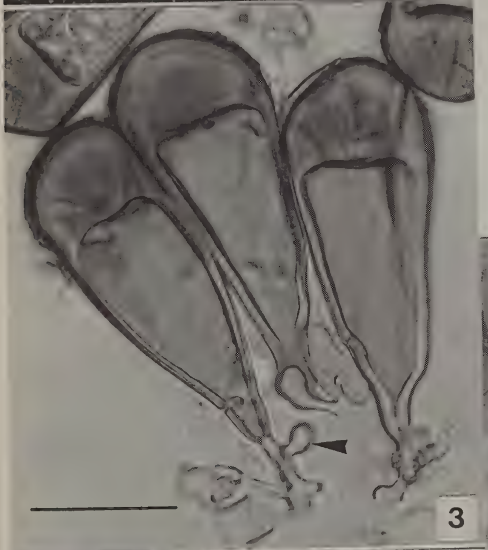
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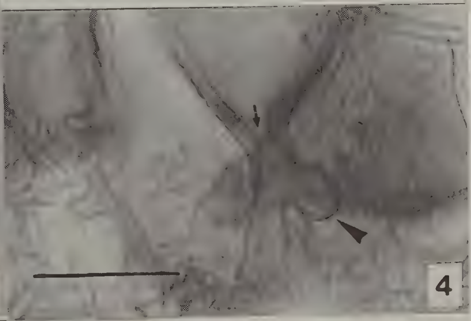
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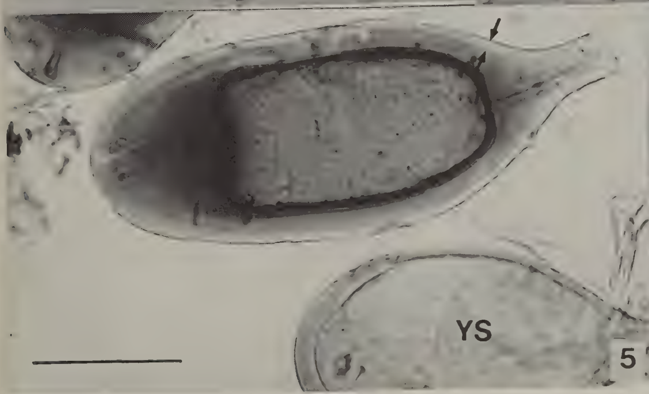
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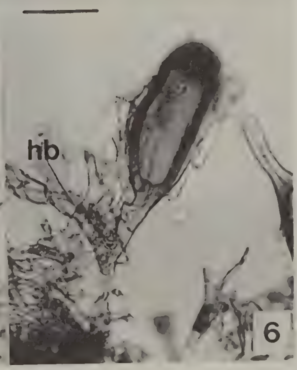
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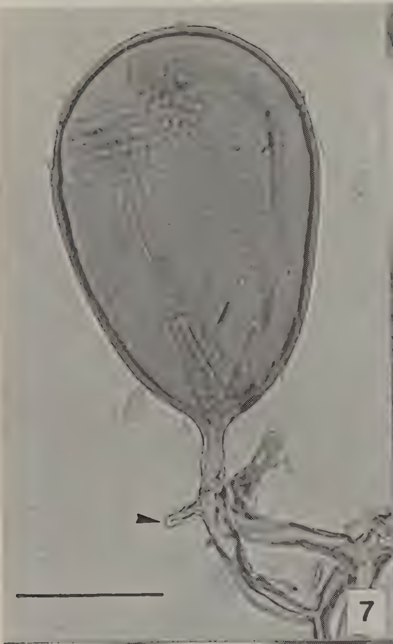
similar type of septum occurs in *S. sinuosa* and *S. taiwanensis* (Fig. 3). Septa are also present in the subtending hyphae of *S. rubiformis*; however, they are much thinner than those of *S. coremioides*.

ARRANGEMENT OF CHLAMYDOSPORES IN SPOROCARPS: The chlamydospores of *S. coremioides* are arranged in a hemispherical layer (Figs. 10, 16). The intersporal spaces are traversed by hyphae which grow radially from the central plexus and terminally connect to the peridium. Similar intersporal hyphae occur in *S. sinuosa* and *S. liquidambaris* (Figs. 2, 9). In young sporocarps of *S. rubiformis*, chlamydospores are also arranged in a hemispherical layer (Fig. 12). However, with the subsequent formation of additional chlamydospores, these immature sporocarps are transformed into globular sporocarps with radially arranged chlamydospores.

CHLAMYDOSPORE AND SPOROCARP FORMATION: All of the chlamydospores in sporocarps of *Sclerocystis* are produced from a central plexus. The central plexus ranges from a single flat, stellate cell as found in *S. rubiformis* and *S. taiwanensis* (Figs. 12, 15), to a mass of interwoven hyphae as found in *S. clavispora*, *S. liquidambaris*, *S. sinuosa*, and *S. coremioides* (Figs. 8, 10, 13, 16, 19, 20). The central stellate cell of the plexus in *S. rubiformis* is slightly different from that of *S. taiwanensis*. The former is a thick-walled structure connecting with a monohyphal stalk; however, the latter is a swollen cell initiated by fusion with more than one monohyphal stalk (Figs. 12-15). Among the interwoven plexal hyphae, flat stellate cells as found in *S. rubiformis* are also frequently observed and connected with chlamydospores or

Figures 7-11. Micrographs of *Sclerocystis* spp. Fig. 7. Chlamydospore of *S. coremioides* not occluded by a septum. Note a branch (arrow head) formed on a subtending hypha. Fig. 8. Partial sporocarp of *S. coremioides* showing a slender subtending hypha (arrow heads). Fig. 9. Partial sporocarp of *S. liquidambaris* showing chlamydospores (S) embedded in club shaped structures (P) protruding from the central plexus. Fig. 10. Cross section of sporocarp of *S. coremioides* showing chlamydospores arranged radially in a hemispherical layer. Note the intersporal hyphae connecting between the central plexus and peridium. Fig. 11. Two naked sporocarps of *S. clavispora* (SC) and *S. taiwanensis*. *S. taiwanensis* producing remarkable smaller sporocarp. Scale bars in figures 7, 8, 9 =30 μm.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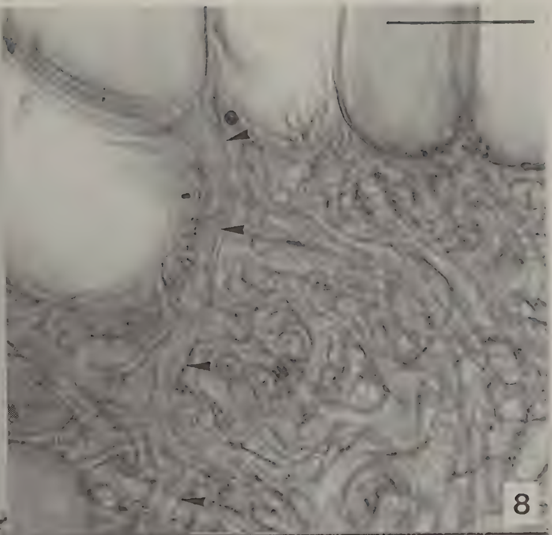
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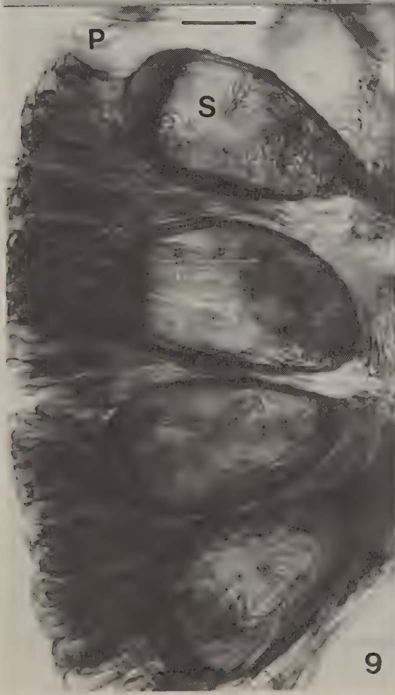

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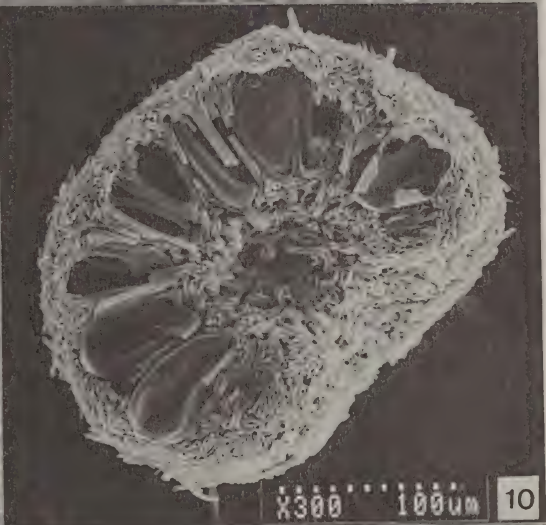

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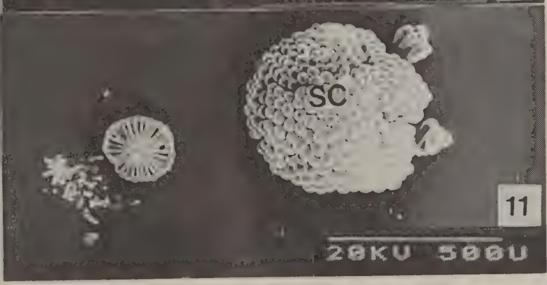
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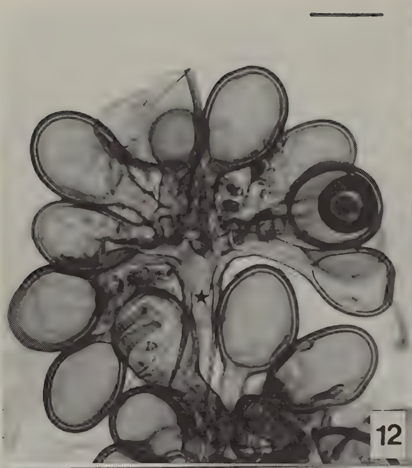
intersporal hyphae (Fig. 19). Sporocarps of *S. coremioides* are frequently produced in columns or branched structures through lateral or distal proliferation. Nevertheless, the sporocarps of *S. rubiformis* are frequently interconnected into a flat piece (>2 cm diam.) by a monohyphal stalk. Among the collections of *S. taiwanensis*, a few young sporocarps were isolated and all of the chlamydospores were vesicular in appearance (Fig. 14). The apical wall of chlamydospores is formed last as sporocarps mature (Figs. 3, 17, 18). A similar type of spore formation is also found in *S. clavispora* (Fig. 5).

HYPHAL STALK OF SPOROCARP: One of the main characters in *S. coremioides* is its hemispherical sporocarp with a hyphal stipe (Fig. 16). The hyphal stipe is a rope of interwoven hyphae. However, other species of *Sclerocystis* are only associated with one or more monohyphal stalks (Figs. 12, 14, 20). These monohyphal stalks are usually thick-walled. Young sporocarps of *S. rubiformis* with a monohyphal stalk are very similar to those of *S. coremioides*, excluding the absence of peridia and intersporal hyphae (Fig. 12).

GERMINATION OF SPORES: Germinating sporocarps of *S. coremioides* and *S. sinuosa* have often been observed. Spores germinate from intact sporocarps, producing extramatrical vesicle-like structures.

Figures 12-16. Micrographs of *Sclerocystis* spp. Fig. 12. A young sporocarp of *S. rubiformis* showing spores arranged in a broom shape. Note the plexus connecting with a monohyphal trunk (asterisk). Scale= 30 µm. Fig. 13. A fragment of sporocarp of *S. sinuosa* showing sinuous peridial hyphae and simple interwoven plexal hyphae. Fig. 14. A primordial sporocarp of *S. taiwanensis* connecting with three monohyphal stalks (arrow heads). Note spores in a vesicular stage (V). Scale= 30 µm. Figs. 15. A swollen central plexus of *S. taiwanensis* actively projecting out to form spores. Note the presence of a broad hyphal trunk (HT) and vesicles (arrows). Scale= 30 µm. Fig. 16. Cross section of sporocarps of *S. coremioides* showing a hyphal stipe (HS), central plexus (PL) and spores produced in a hemispherical layer. Central plexal hyphae are comparatively broader than subtending hyphae of spores. Scale= 100 µm.



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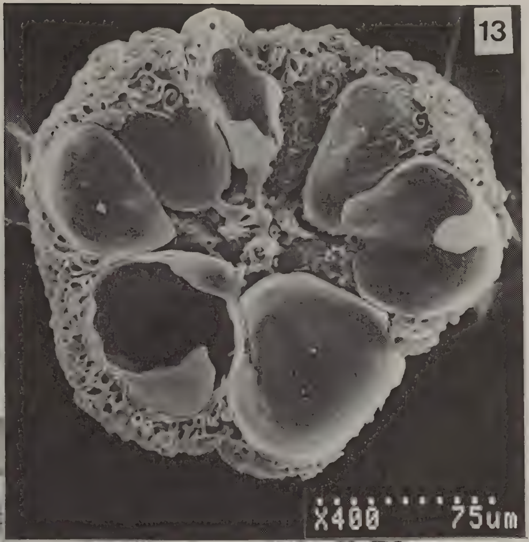

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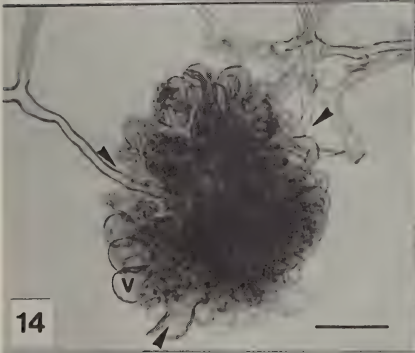

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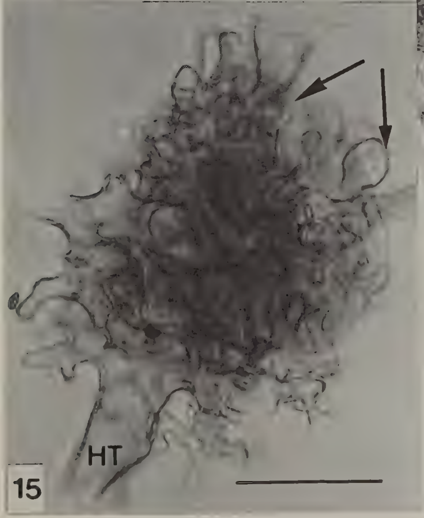

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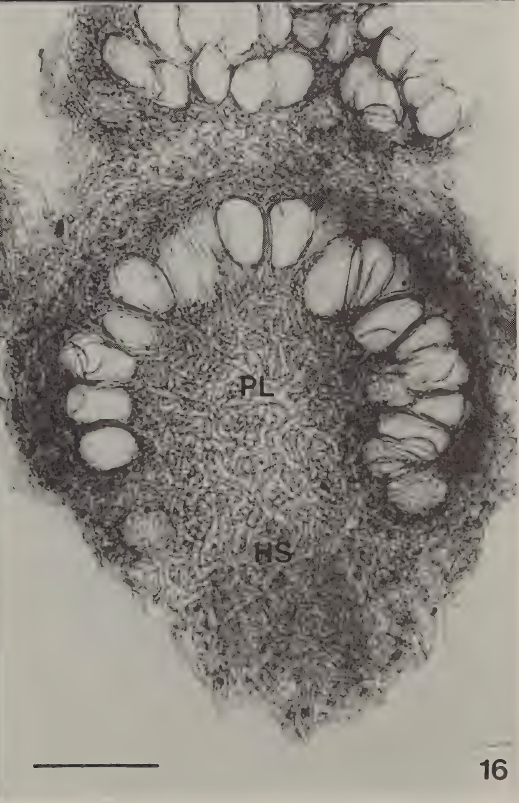

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DISCUSSION

The Species of *Sclerocystis* included in the present study form a natural grouping on the basis of method of sporophore formation, spore germination, chlamydospore and sporocarp production, and the appearance of the septa and hyphal stalks of the sporocarps (Table 1). The affinity of *S. coremioides* is closer to the other species of *Sclerocystis* than to *Glomus*. Although three species of *Glomus*, *i.e.*, *G. ambisporum*, *G. heterosporum* (Smith and Schenck, 1985), and *G. dimorphicum* Boyetchko and Tewari (1986) produce sporocarps similar to those of *S. rubiformis* the ability to produce dimorphic chlamydospores clearly distinguishes them from *Sclerocystis*. Dimorphic species, *G. ambisporum*, *G. heterosporum* and *G. dimorphicum,* appear to be transitional taxa linking *Glomus* and *Sclerocystis*, because they exhibit generic features of both. To date, these three species appeared to be only distributed in North America. The chlamydospores in sporocarps of *Glomus* were mostly arranged randomly and could be enclosed by a peridium or naked.

Evolutionary trends of sporocarps in *Sclerocystis* are visible through a comparison of their structures (Fig. 21). Sporocarps of *S. rubiformis* are considered as primitive due to their lack of a peridium and producing sporocarps from a simple, broad, thick-walled plexal cell. Sporocarp aggregates were not uncommonly isolated and were interconnected by a single "fecund" hypha which was the same as that found in *G. ambisporum* (Smith and Schenck, 1985). In the naked sporocarps of *S. taiwanensis* , the central plexus is more complicated than in *S. rubiformis* and is formed by more than one monohyphal stalk (Fig. 15). *Sclerocystis clavispora* produces sporocarps similar to *S. taiwanensis*, but the central plexus is replaced by interwoven hyphae. Nevertheless, broad, thick-walled stellate cells similar to those of

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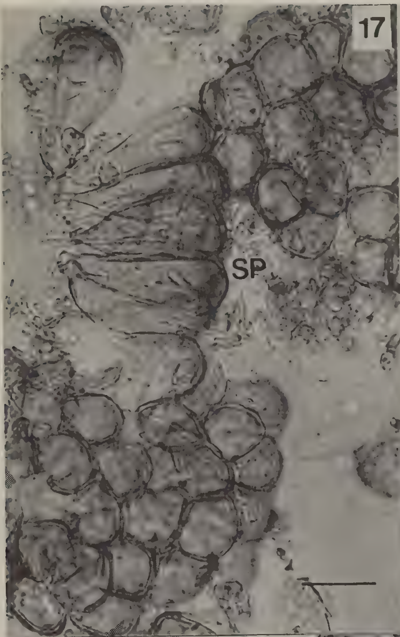
Figures 17-20. Micrographs of *Sclerocystis* spp. Fig. 17. Crushed young sporocarp of *S. taiwanensis* showing thin-walled spores (SP). Scale= 30 µm. Fig. 18. Mature sporocarp of *S. taiwanensis* showing the gradually thickened apex of spore walls. Note a monohyphal stalk (arrow head) connecting with plexus. Scale= 30 µm. Fig. 19. A broad, thick-walled cell (arrow head) in the central plexus of a sporocarp of *S. liquidambaris*. Scale= 30 µm. Fig. 20. Aperidial sporocarp of *S. sinuosa* showing four monohyphal stalks (arrow heads). Scale= 100 µm.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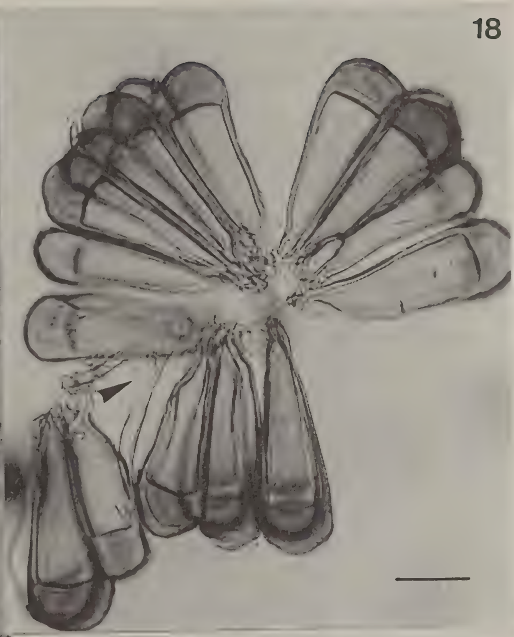
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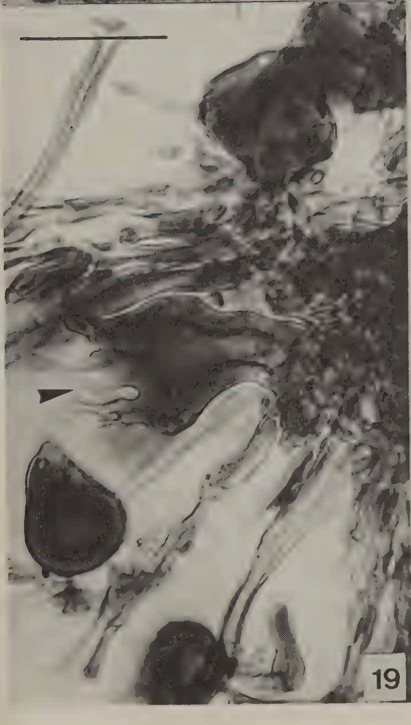
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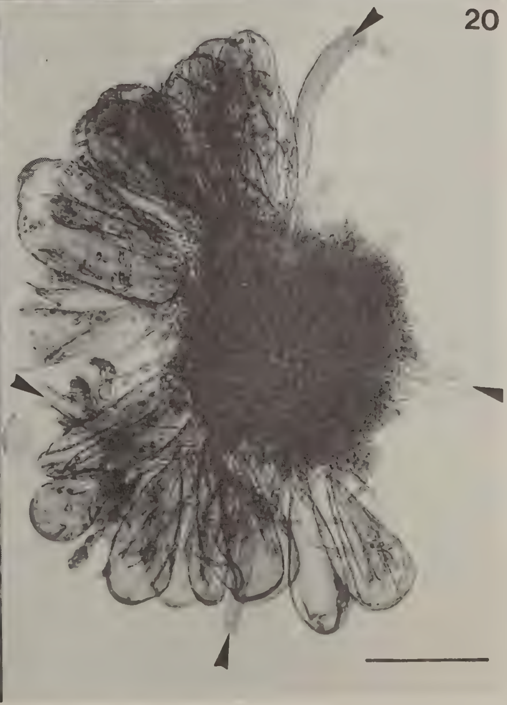
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S. rubiformis are often mixed in the plexus. Consequently, *S. clavispora* is thought to be advanced *S. taiwanensis*, and both are senior to *S. rubiformis*. *Sclerocystis liquidambaris* appears to be derived from the *S. clavispora/S. taiwanensis* type, with the hyphal branches arising from the base of the spores becoming thick walled. The peridium of *S. liquidambaris* is thought primitive if compared with that of *S. sinuosa* and *S. coremioides*, since it is only tightly packed by thick-walled, clubshaped cells. In the sporocarps of *S. sinuosa* and *S. coremioides*, however, a peridium of interwoven hyphae is well developed. The peridial hyphae originate from the central plexus (Figs. 10, 16). *Sclerocystis sinuosa* has a number of monohyphal stalks radiating out of sporocarps. Thus, it resembles *S. coremioides*, except that the monohyphal stalks of this species are all combined into a coarse stipe. A single monohyphal stalk has the ability to produce a broomlike fruiting body, and further develops into a globose sporocarp as found in *S. rubiformis* (Fig. 12). However, the fusing of many monohyphal stalks into a stipe would result in a lose of the ability to produce spores in a globular arrangement. The result would be a hemispherical sporocarp.

Results of this study support the retention of the generic concept of *Sclerocystis* as proposed by Gerdemann and Trappe (1974). However, the definition of *Sclerocystis* is modified as following.

SCLEROCYSTIS Berk. & Br. emend. Wu

Sporocarps globose or subglobose or hemispherical, enclosed by a peridium or naked, with a multihyphal stipe or monohyphal stalks; chlamydospores arranged side by side in a single layer, radiating out from a central plexus of hyphae; central plexus composed of a broad, stellate thick-walled cell or interwoven hyphae; development of chlamydospores within sporocarps synchronous or asynchronous; sidebranches frequently produced from the base of chlamydospores, becoming spores or intersporal hyphae.

Fig. 21. Diagram of sporocarpic evolution of *Sclerocystis* spp. A. *S. rubiformis*, B. *S. clavispora* and *S. taiwanensis*, C. *S. liquidambaris*, D. *S. sinuosa*, E. *S. coremioides*.

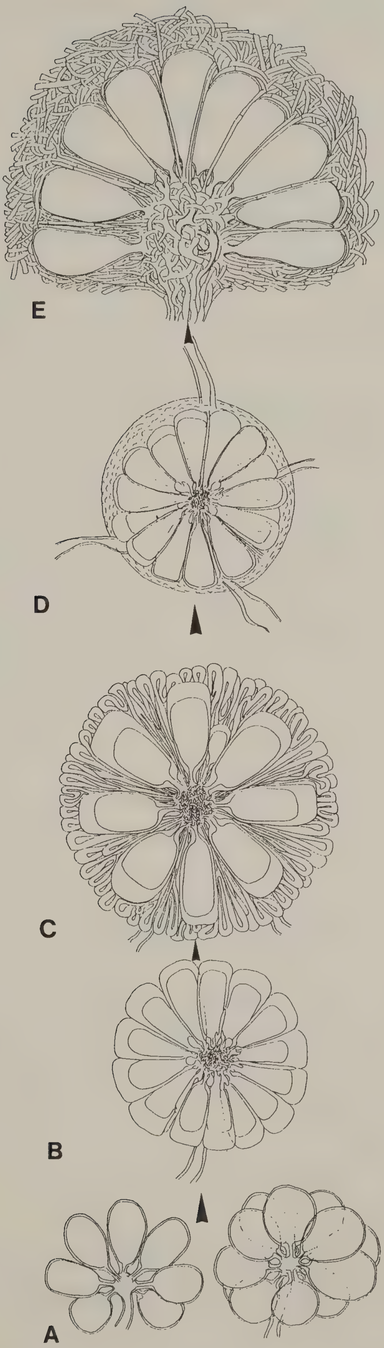

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TABLE 1. COMPARISON OF SPORE ONTOGENY AND SPOROCARP FORMATION IN *SCLEROCYSTIS*

CHARACTERISTICS	***S. COREMIOIDES***	***SCLEROCYSITS* spp.**
SPOROCARP FORMATION	in chains or branches	in flat pieces (*S. rubiformis*)
SPOROCARP GERMINATION	vesicle structures	vesicle structures (*S. sinuosa*)
SPOROCARP STALK	stipe	monohyphal stalk (*S. rubiformis*) more monohyphal stalks (*S. sinuosa*, *S. taiwanensis*..etc)
SPOROPHORE FROM BASE OF CHLAMYDOSPORES	present	present

ACKNOWLEDGEMENT

This research was financially supported by National Science Council of Taiwan, Republic of China (NSC 82-0409-B-055-013). Appreciation is extended to Drs. R. E. Koske, James W. Kimbrough, and G. L. Benny for their critical reviews of this manuscript and for providing specimens used in this research.

LITERATURE CITED

Almeida, R. T. and N. C. Schenck. 1990. A revision of the genus *Sclerocystis* (Glomaceae, Glomales). **Mycologia** 82:703-714.

Gerdemann, J. W. and J. M. Trappe. 1974. The Endogonaceae in the Pacific Northwest. Mycologia Memoir No. 5, 76p.

Iqbal, S. H. and B. Perveen. 1980. Some species of *Sclerocystis* (Endogonaceae) from Pakistan. **Trans. Mycol. Soc. Japan** 21:57-63.

Madelin, M. F. 1979. An appraisal of the taxonomic significance of some different modes of producing blastic conidia. Pp. 63-80. *In*: The Whole Fungus. Vol. 1. Ed., B. Kendrick. National Museum of Canada, Ottawa.

Smith, G. W. and N. C. Schenck. 1985. Two new dimorphic species in the Edogonaceae: *Glomus ambisporum* and *Glomus heterosporum*. **Mycologia** 77:566-574.

Trappe, J. M. 1977. Three new Endogonaceae: *Glomus constrictus*, *Sclerocystis clavispora*, and *Acaulospora scrobiculata*. **Mycotaxon** 6:359-366.

Wu, C.-G. and Z. C. Chen. 1986. The Endogonaceae of Taiwan. I. A preliminary investigation on Endogonaceae of bamboo vegetation at Chi-tou areas, Central Taiwan. **Taiwania** 31:65-88.

Wu, C.-G. and Z. C. Chen. 1987. The Endogonaceae of Taiwan. II. Two new species of *Sclerocystis* from Taiwan. **Trans. Mycol. Soc. Rep. China** 2:73-83.

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SYSTEMATIC AND BIOLOGICAL STUDIES IN THE BALANSIEAE AND RELATED ANAMORPHS. III. ASCOSPORE AND MACROCONIDIAL GERMINATION AS A TAXONOMIC CRITERION

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ABSTRACT

Ascospore and *Ephelis* macroconidial anamorph germination *in vitro* on agar media is described in *Balansia aristidae* Diehl and *B. epichloe* (Weese) Diehl, and ascospore germination in *Myriogenospora atramentosa* (Berk. & Curt.) Diehl. A review of the literature on the subject of spore germination in the Balansieae is presented. Consideration is given to the usefulness of differing germination patterns in the taxonomy of the tribe, including species of *Atkinsonella* Diehl, *Balansia* Speg. and *Epichloe* (Fr.) Tul. It appears that, in the taxa so far studied in detail, differences occur that are reflective of both generic and specific distinctions.

INTRODUCTION

As alluded to in the prologue to this series of papers (Morgan-Jones *et al.*, 1992), a number of problems exist in the taxonomy of the Balansieae. These have arisen partly because of a limited number of criteria, including host relationships, and overall morphology of conidial and perithecial stroma, used in delimiting taxa. In many instances, species distinctions are not readily apparent solely on the basis of host specificity and/or stroma morphology. In the case of *Balansia aristidae* and *B. strangulans* (Mont.) Diehl, for example, their stromata are essentially similar except for the fact that in the former perithecia are more prominent. Likewise, their *Ephelis* anamorphs are virtually indistinguishable. During the course of the present studies, attempts are being made to evaluate additional criteria of potential taxonomic usefulness. Among them are details of host-pathogen interactions, *in vitro* colony growth characteristics and peculiarities of ascospore and *Ephelis* macroconidial germination. It is also anticipated that analysis of molecular sequence data will aid in resolving questions of relatedness among taxa in this complex.

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Diehl (1950) reported studying the germination of the *Ephelis* macroconidia of six species of *Balansia* in tap and rain water and on the surface of sterile agar media. The taxa observed in this regard, except for *Balansia obtecta* Diehl, and the composition of the media, were not specified. Germination of the conidia of *Ephelis mexicana* Fr., the anamorph of *B. obtecta*, was illustrated by a line drawing. No clear distinction was found in conidial appearance or germination among the species. Both a single primary apical germ tube and also lateral ones were reported to be produced. Diehl (loc. cit) described the acicular *Ephelis* conidia as being characterized by indentations that were thought to be due to the presence of septa, although these could not be discerned in most species. A tendency for conidia to break apart at one or two slight constrictions was also considered to indicate occurrence of septa. Septa were reported to occur in the macroconidia of *Balansia linearis* (Rehm) Diehl and ascospores were said to develop septa before or at germination. When the latter occurs, each cell may form one or more germ tubes perpendicular to the axis of the ascospore. Some swelling of the segments of the ascospores of *B. linearis* at germination was illustrated.

Ullasa (1969), in a study of *Balansia claviceps* Speg. *in vitro*, investigated conidial and ascospore germination in hanging drop cultures. Conidia were found to swell considerably in water and water agar prior to germination. After forty-eight hours, one to five polar and lateral germ tubes were formed. At this stage conidia became variously septate and individual cells became somewhat bulbous and produced more than one germ tube. After seventy-two hours germ tubes branched or remained simple and formed whorls of secondary conidia at their tips similar in morphology to the parent conidia. Such conidia either germinated or produced tertiary conidia by a budding process. On potato dextrose agar slow-growing yeast-like colonies consisting mainly of masses of conidia were produced. Ascospores germinated similarly by germ tubes, at the tips of which whorls of conidia were formed.

Luttrell and Bacon (1977) reported that in *Myriogenospora atramentosa*, which they classified in the Balansieae, one-celled part-ascospores consistently germinated by forming an aborted foot at one end and a coiled germ tube at the other. The germ tube failed to develop into a hypha on common laboratory media. It was also stated that in species of *Balansia* each ascospore cell may germinate by a coiled germ tube produced laterally just below each septum. The *Ephelis* anamorph was described as "fusoid conidia produced on phialides at the surface of the stroma" but no account of conidial germination was given. Subsequently Rykard *et al.* (1982) showed the *Ephelis* state of this species to have holoblastic, sympodial conidiogenous cells and described conidial germination. This was found to be characterized by the development of bipolar or lateral germ tubes. In a liquid medium (referred to as M102), conidia germinated by forming bulbous, flattened, spoon-shaped ends which produced elongated germ tubes. On cornmeal malt extract (CMM) and water agar (WA), branched or unbranched, determinate germ tubes functioned as conidiogenous cells, producing a sequence of secondary conidia. No mention was made of any conidial septation.

Conidium production from ascospores, without an intervening hyphal phase, is known to occur in a number of ascomycetes. Several didymosporous, phragmosporous and dictyosporous species belonging to the *Nectria* Fr. complex, for example, produce microconidia, often referred to as ascoconidia, from ascospores while still remaining within asci. In *Nectria aquifolii* (Fr.) Berk. and *N. coryli* Fuckel numerous microconidia are formed from minute, open-ended, tube-like extensions at both ends of their one-septate ascospores, and their ontogeny is considered to be phialidic (Booth, 1959). Likewise, microconidia are produced from the multiseptate ascospores of *Scoleconectria cucurbitula* (Tode:Fr.) C. Booth through minute openings in their walls. (Booth, loc. cit.). Rossman (1983) described the ascospores of this fungus as 'budding' to form ascoconidia. A similar process occurs in species of *Thyronectria* Sacc., including *T. balsamea* (Cooke & Peck) Seeler, *T. berolinensis* (Sacc.) Seaver and *T. lamyi* (Desm.) Seeler. In all of these taxa ascospores never produce germ tubes but rather disintegrate following microconidial production.

Ascospore germination in *Epichloe typhina* (Pers.:Fr.) Tul. was investigated by Bacon and Hinton (1988) on CMM and water agar. A process, referred to as iterative germination, was reported to occur in which ascospores produced lateral, aculeolate, phialidic conidiogenous extensions perpendicular to their long axis. One such entity was produced from each cell of the ascospore and sometimes delimited from it by a transverse septum, sometimes not. Each conidiogenous element produced several conidia terminally. Under varied conditions, germ tubes leading to hyphal development were never produced.

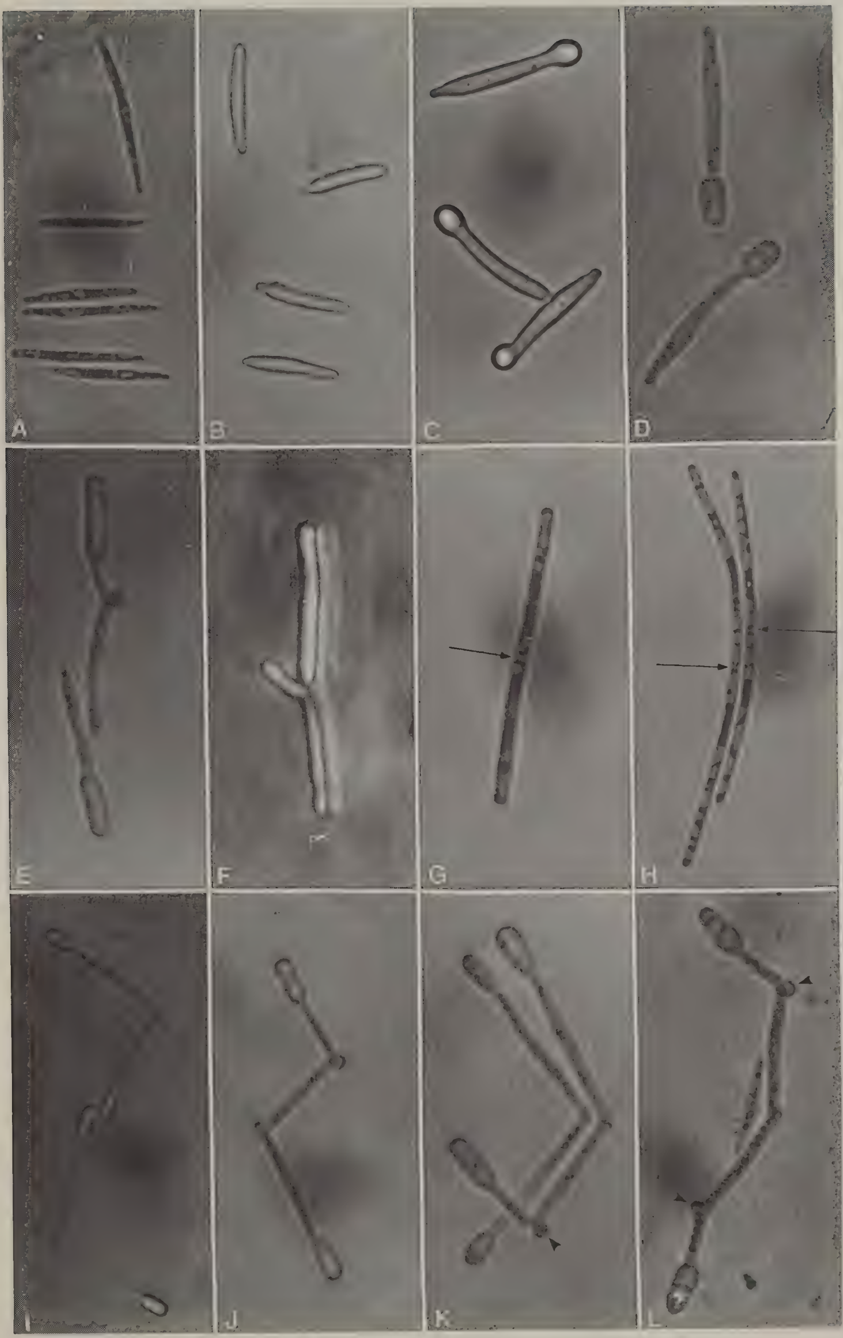
Germination of discharged ascospores of *Atkinsonella hypoxylon* (Peck) Diehl and *A. texensis* (Diehl) Leuchtmann & Clay was studied by Leuchtmann and Clay (1989) on cornmeal-dextrose agar. This was found to be of an identical pattern in both species. Within the ascus ascospores are usually seven-septate but split at their median septum, where they are constricted, into two four-celled part-ascospores prior to germination. Germ tubes were found to be initially produced, one per cell, at both ends of the part-ascospores and laterally, immediately below the septa delimiting the end cells. No germ tube was produced in the vicinity of the median septum of each part-spore. At a later stage, the part-ascospores often split further, at their median septum, and additional germ tubes were formed from free ends or from the base of existing tubes. No study of *Ephelis* anamorph conidial germination in these species was reported.

We have had opportunity to study *Balansia aristidae, B. epichloe,* and *Myriogenospora atramentosa in vivo* on grasses in Alabama and the former two have been brought into pure culture. It is clear from previous reports that ascospore and/or conidial germination patterns differ between genera and, at least in some instances, between species of the Balansieae. In order to further evaluate the possible usefulness of modes of germination in the taxonomy of the tribe, ascospore and conidial germination characteristics of the two *Balansia* species, and ascospore germination in *M. atramentosa*, have been investigated and are reported upon herein.

MATERIALS AND METHODS

Plants of *Aristida purpurascens* Poir., *Eragrostis capillaris* (L.) Nees, and *Paspalum notatum* Flüggé, bearing stromata of *B. aristidae*, *Balansia* *epichloe*, and *Myriogenospora atramentosa*, respectively, were collected from sites in Lee, Montgomery, and Tallapoosa counties during early to mid summer 1991. Voucher specimens from these collections have been deposited in the Auburn University Mycological Herbarium (AUA) and at BPI. Infected plants were transplanted into 15 cm diameter plastic pots containing local sandy loam and grown in a Conviron growth chamber. An environment of 90% relative humidity and alternating 12-hour light/dark periods (provided by incandescent and fluorescent lights) at temperatures of 32° C and 24° C respectively, was maintained. Using a sterile dissecting needle, macroconidial masses were scraped from superficial ephelidial pustules on culm-borne stromata of *B. aristidae* and from leaf-borne stromata of *B. epichloe*. No conidia were harvested from *Myriogenospora atramentosa*. Ascospores were harvested from all three taxa by cutting off the tops of several mature, stroma-borne perithecia horizontally with a razor blade, followed by removal of their exposed contents with a sterile needle. Both conidia and ascospores harvested by these methods were immediately suspended in sterile distilled water. Spore suspensions were then diluted to appropriate concentrations, and plated on each of three media. The media used during this study were 2% WA, CMM, and EC-14 (3 g KH_2PO_4, 2 g K_2HPO_4-$3H_2O$, 2 g NH_4SO_4, .5 g $MGSO_4$-$7H_2O$, 40 g mannitol, 10 g yeast extract, 20 g agar, + water to equal 1 L), a medium developed by the late Edward M. Clark and Richard A. Shelby at Auburn University for grass endophyte culture (unpublished). Using a glass rod, approximately .3 ml of spore suspension was spread onto the surface of the medium in each petri plate. Ascospores were also harvested by taping mature perithecial stromata inside the lids of petri plates and awaiting the forcible discharge of ascus contents onto the agar surface below. After 1, 2, or 4 hours the stromata were removed and the plates sealed. Germinating spores were observed *in situ* with a Zeiss microscope using low power objectives. Limitations of such observations included compromised resolution and contrast resulting from the relatively thick agar background, and inability to study the spores at high magnification due to lack of clearance for an oil immersion lens. Attempts to transfer germinating spores from petri plates to microscope slides generally resulted in damage to the spores. To enhance imaging, and enable viewing at high magnification, spores were allowed to germinate on medium-coated 22 mm #1 slide coverglasses. Coverglasses were dipped in hot agar medium and placed inside petri plates on the surface of the same medium to prevent desiccation. After adding the spore suspension to the upper exposed surface of the coverglasses and allowing the excess liquid to evaporate, the petri plates were sealed and incubated at 25° C. Inoculated coverglasses were

PLATE 1. *Balansia aristidae*. A-F, *Ephelis* conidia; A, from nature; B, initial swelling on agar medium; C, apical swelling (early stage); D, apical swelling (later stage); E & F, apical swelling (final stages), and initiation of primary germ tubes: G-L, part-ascospores; G & H, from mature perithecium (median septa indicated by arrows); I, median disarticulation and terminal swelling (early stage); J-L, median disarticulation and terminal swelling (later stages), lateral germ tube initiation (indicated by arrowheads) and disarticulation of swollen ends.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removed periodically during germination, inverted, and mounted on hanging-drop slides with the surface bearing spores downward. Prior to viewing, excess agar was gently wiped from the upper surface of the mounted coverglass. When standard slides were used instead of hanging drop slides, germinating spores were frequently damaged.

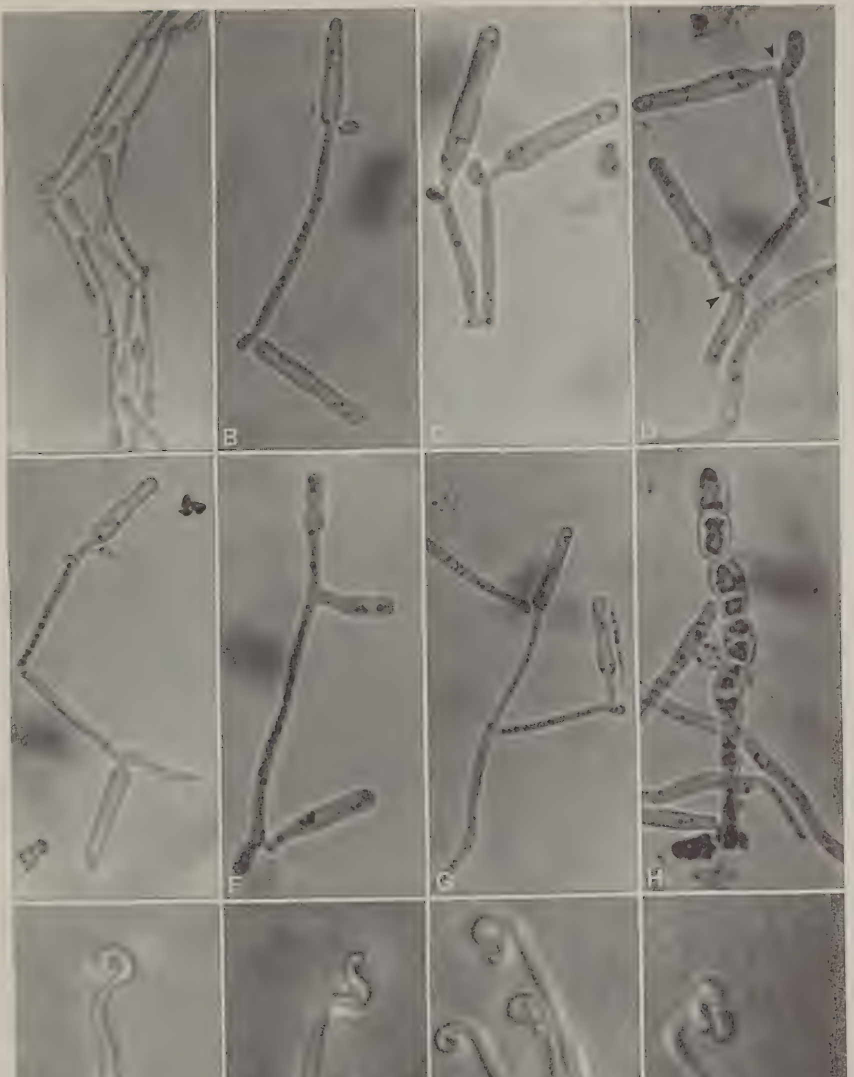
RESULTS

Balansia aristidae. Conidia.

Conidia of this species are long, cylindrical to somewhat fusiform, obtuse at the apex, subtruncate at the base, 10 to 15 µm long and less than 1 µm wide (Plate 1, A; Figure 1, A). Germination by germ tube occurred after 4 days on EC-14 and CMM media and was preceded by morphological changes. Following 48 hours on these media, conidia swelled appreciably at their apex to form an ellipsoid to oblong portion about 3 µm in length and 2 µm wide, while the opposite, basal end remained more or less truncate (Plate 1, A & B; Figure 1, B). After 5 days the swollen portion became much more elongate (up to 7 µm), assuming a long-oblong or more or less cylindrical aspect or, in some cases, became narrowly obpyriform (Plate 1, D; Figure, 1, B). Initial germination was mostly monopolar but variable. A primary germ tube often originated from the conidium immediately below the base of the terminal swelling or a short distance below it (Plate 1, E & F). Alternatively, more rarely, a germ tube originated apically. Occasionally this was followed shortly thereafter by disarticulation of the terminal swelling from the remainder of the conidium. After 10 days, some swollen terminals became up to 12 µm long where apical germination did not occur. Following initial germ tube production a secondary germ tube sometimes originated proximal to the first. In some instances, following a period of 12 days, a germ tube was also produced from the opposite, basal end of the conidium. Many conidia underwent the described morphological changes but failed to germinate after 10 days.

Although most conidia failed to germinate on WA, germination followed a similar course except that terminal swelling was delayed 24 to 48 hours and never developed beyond 3.5 µm in length. After 12 days a small percentage developed a swollen spherical structure up to 6 µm in diameter (Figure 1, C), located distal to the already swollen oblong, terminal portion, frequently giving rise to one or two germ tubes. Such germ tubes generally developed into extensive hyphal systems. Though rare, hyphae sometimes also emerged from the basal end.

PLATE 2. A, *Balansia aristidae* part-ascospores 72 hours after direct discharge onto agar medium; B-G, part-spores after 4 to 7 days on agar media showing various stages of terminal swelling, median and terminal septation and disarticulation (indicated by arrowheads), and sympodial germ tubes; H, chlamydospore-like cells arising from a part-spore on agar medium; I-L, *Myriogenospora atramentosa* part-ascospores showing stages of germination and germ-tube branching.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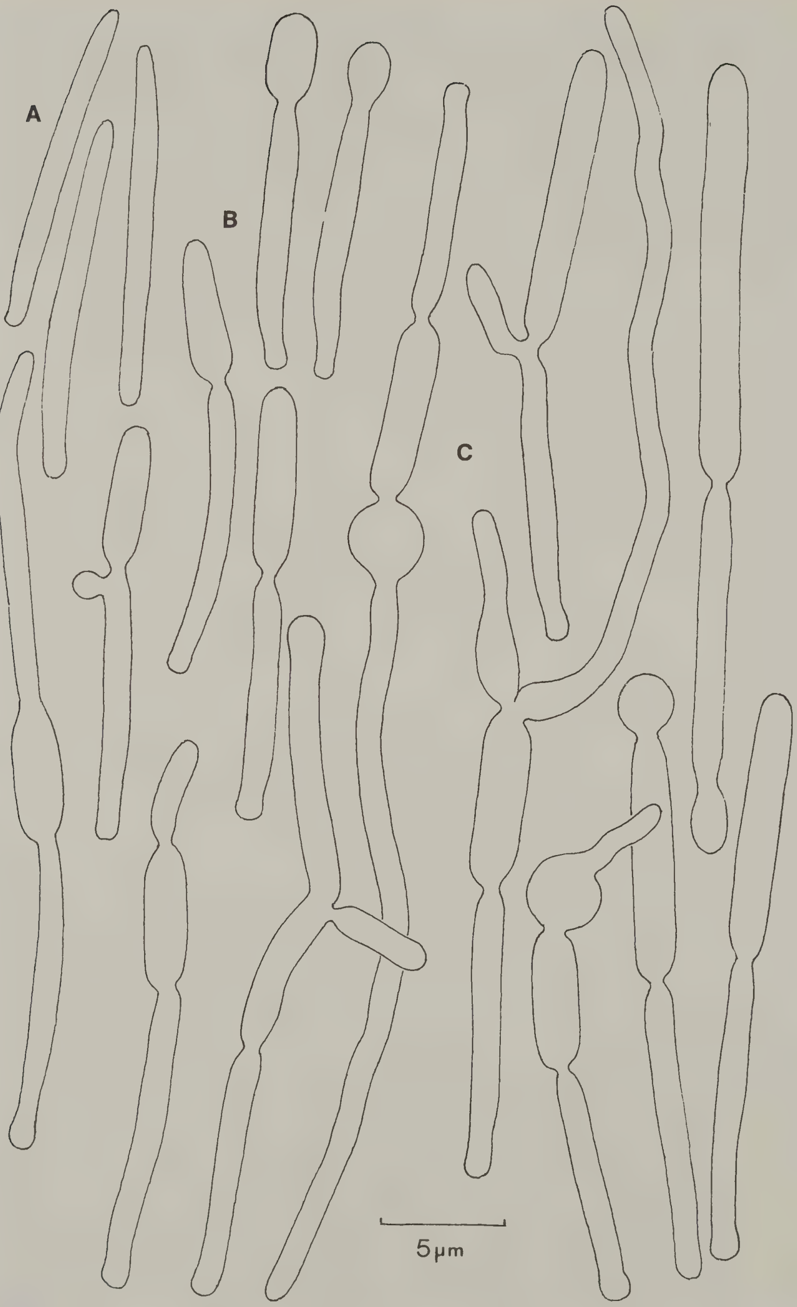


FIGURE 1. *Balansia aristidae, Ephelis* conidia. A, from nature; B & C, stages and patterns of germination.

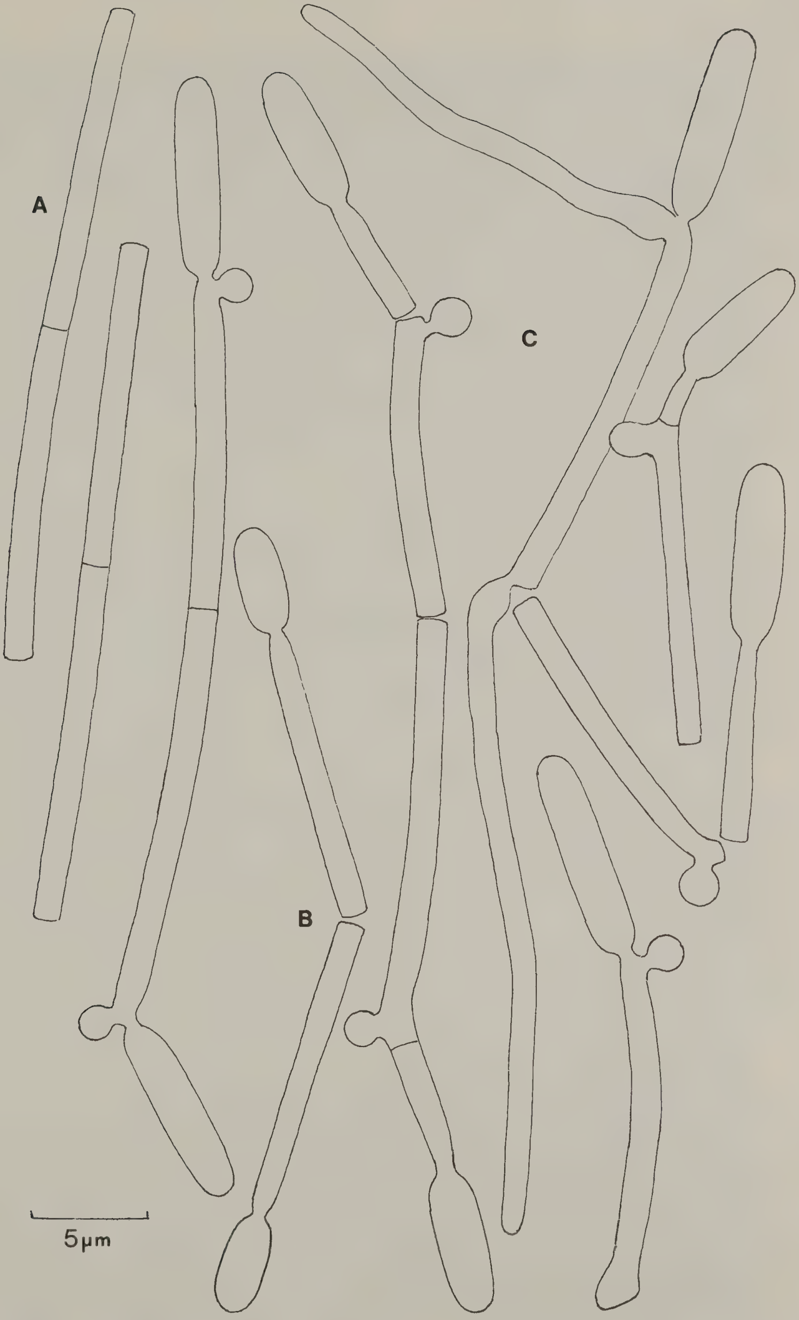


FIGURE 2. *Balansia aristidae* part-ascospores. A, from nature; B & C, various stages of germination, septation and disarticulation.

Ascospores.

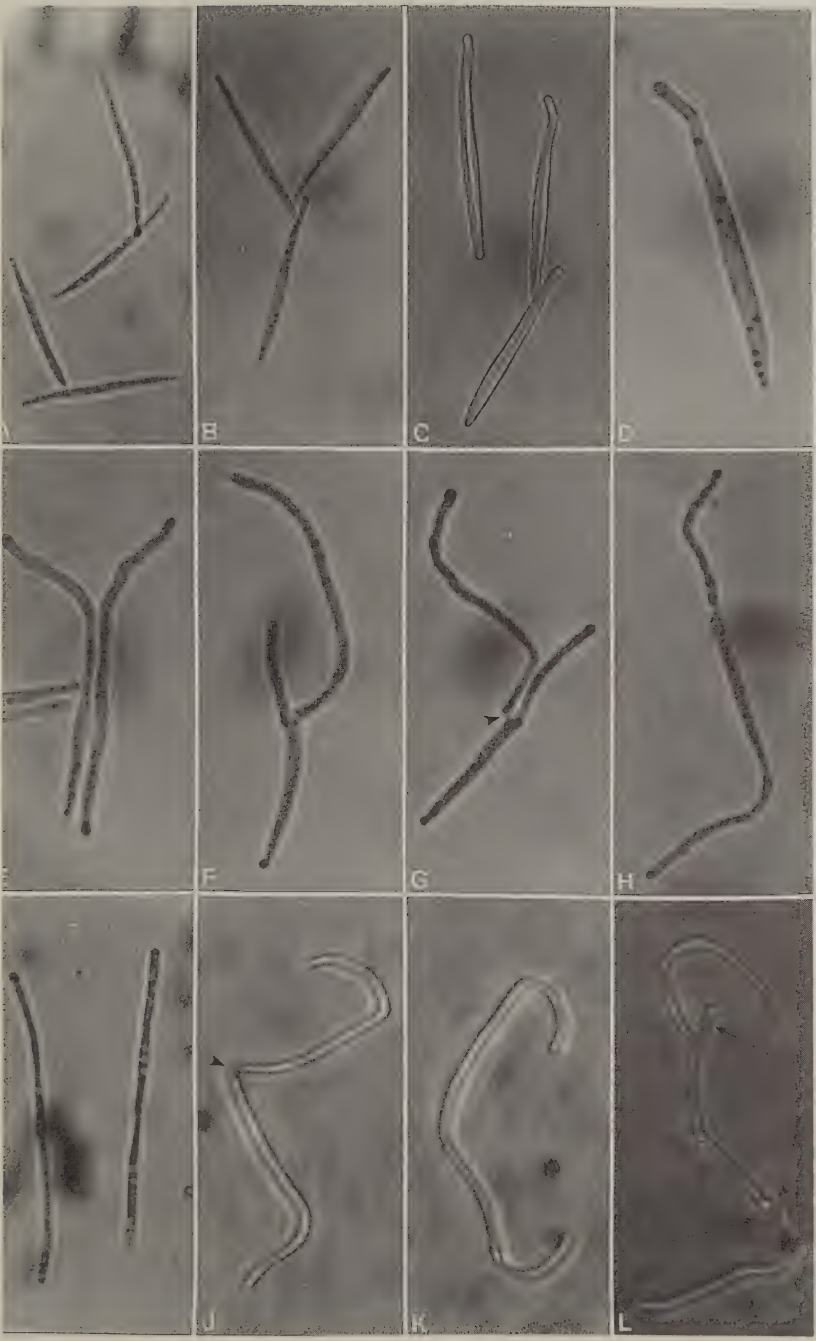
Ascospores of *Balansia aristidae* disarticulate within the asci, forming one-septate part-spores which are then discharged. Part-spores are narrow and cylindrical with truncate ends, 21 to 34 µm in length and less than 1 µm wide (Plate 1, G & H; Figure 2, A). After 48 hours on EC-14 medium, part-spores swelled at both ends forming bulbous, ellipsoid terminals 3.5 to 4.5 µm in length and disarticulated at the median septum (Plate 1, I; Figure 2, B). Following another 48 hours, the swollen ends became nearly 9 µm long. Lateral germ tubes developed directly or a short distance below the terminal swellings (Plate 1, H; Plate 2, B & C). Concurrently or immediately before germ tube initiation, a septum was laid down just above its point of origin. Disarticulation of the swollen terminal from the remainder of the half part-spore frequently occurred at this septum (Plate 2, D). After 7 or more days, some swollen ends reached 14 µm in length and a second germ tube was occasionally produced from the base of the half part-spore (Plate 2, G; Figure 2, C). A few half part-spores swelled appreciably, becoming multiseptate and forming thick-walled, melanized chlamydospore-like structures (Plate 2, H).

Part-spores behaved similarly on WA. Septae and terminal swellings, however, were not as well-defined, and spores became generally more irregular in shape. Lateral and terminal germ tubes occurred frequently after 48 hours, and quickly developed into mycelia. Thick-walled, chlamydospore-like cells also began to occur at 48 hours. After 4 days these structures were extremely common. Following 7 days, part-spores had either failed to swell and began deteriorating, formed mycelia, or formed chlamydospore-like structures.

Balansia epichloe. Conidia.

Conidia of this species are acicular to fusiform, acute at the apex, subtruncate at the base, 16 to 21 µm long and less than 1 µm wide (Plate 3, A; Figure 3, A). Within 24 hours on EC-14 medium conidia swelled slightly and germinated by apical germ tubes, one per conidium. Moderate swelling occurred evenly over the basal two-thirds of the spore, the apical portion remaining more attenuate (Plate 3, B). Just prior to apical germination, the extreme tip swelled slightly (Plate 3, C). After 24 hours germ tubes averaged 7 µm, emerging from a slight enlargement at the apex of the tapered conidium (Figure 3, B). A similar enlargement developed at the basal end also. After 48 hours apical germ tubes approached 12 µm in length. Germination remained monopolar for nearly

PLATE 3. *Balansia epichloe*. A-H, *Ephelis* conidia; A, from nature; B, initial swelling; C & D, further swelling and early stage of germination; E, well-developed apical germ tubes; F & G, disarticulation of initial germ tube(indicated by arrowhead) and initiation of sympodial germ tube; H, bipolar germination; I-L, part-ascospores; I, from mature perithecium; J & K, median disarticulation (indicated by arrowhead) and terminal germination; L, sympodial development of secondary germ tubes (indicated by arrows) and disarticulation of initial terminal germ tubes (indicated by arrowhead).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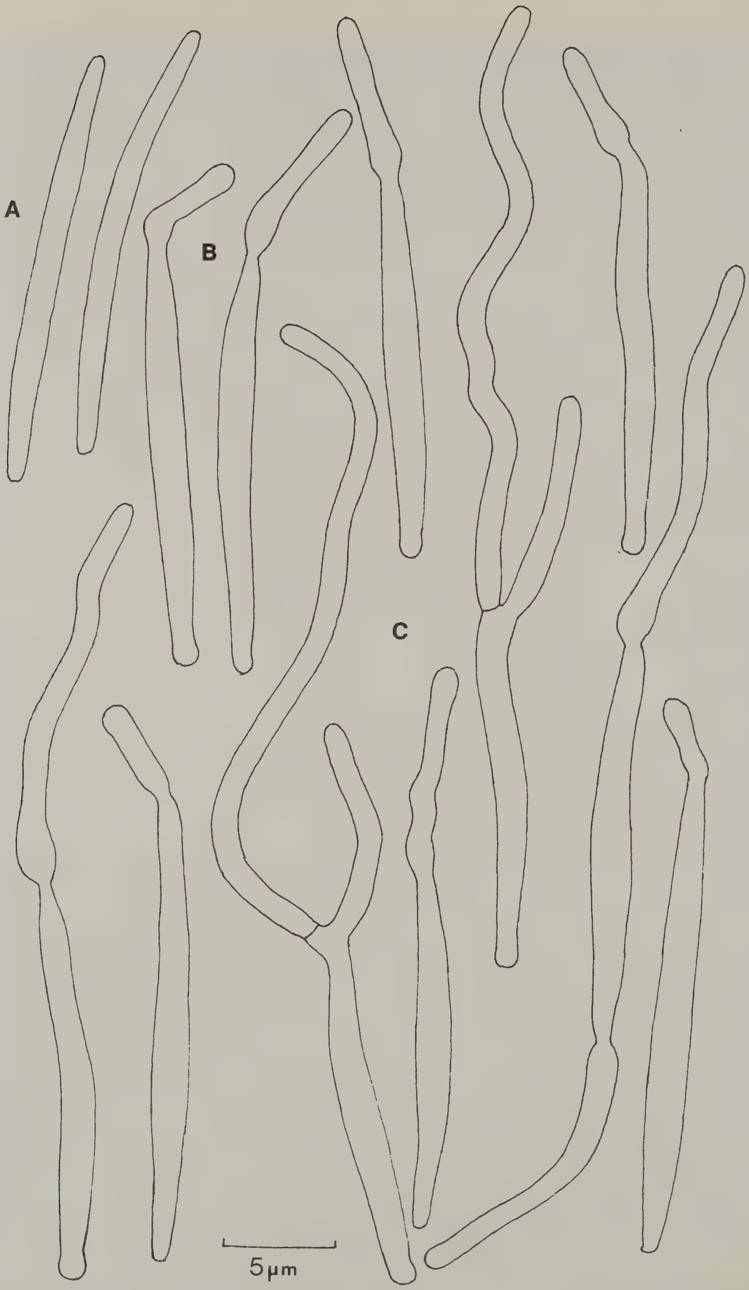


FIGURE 3. *Balansia epichloe, Ephelis* conidia. A, from nature; B & C, stages and patterns of germination.

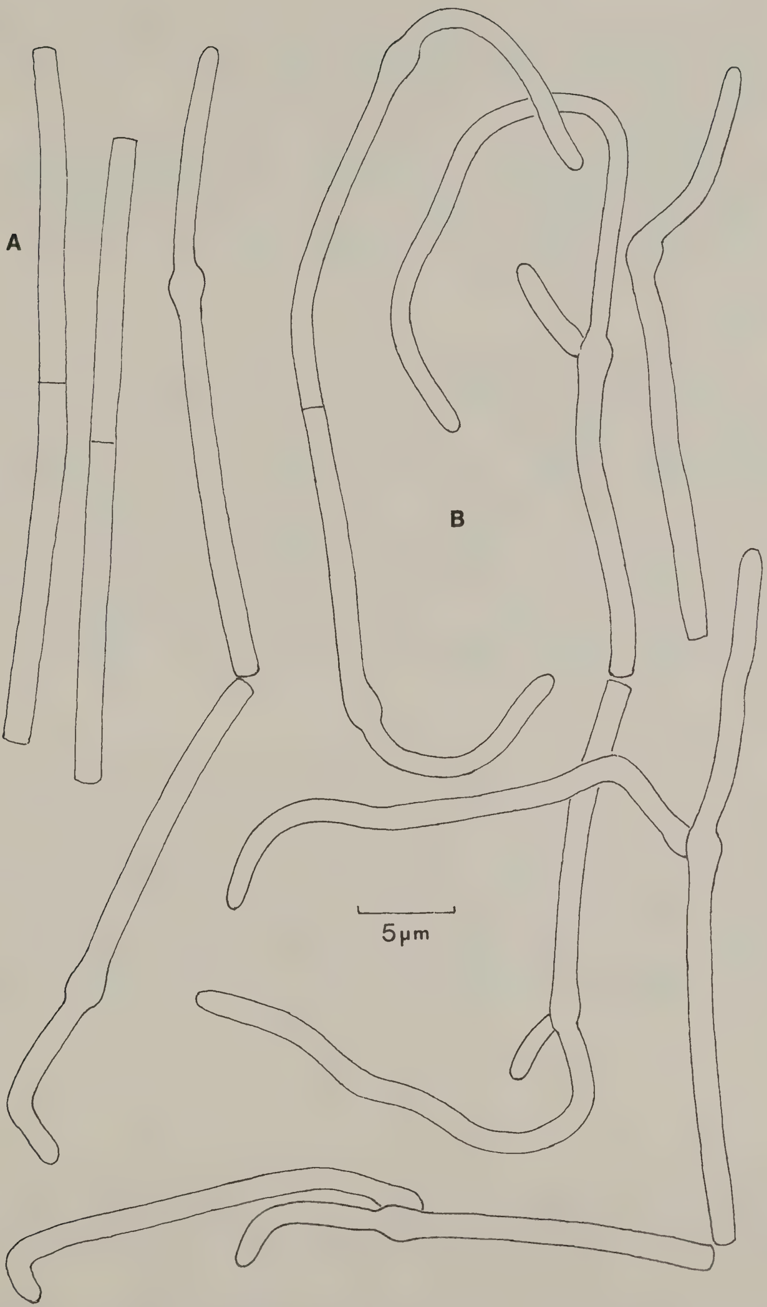


FIGURE 4. *Balansia epichloe* part-ascospores. A, from nature; B, various stages of germination.

5 days, at which time a second germ tube occasionally developed from the basal enlargement (Plate 3, H). More commonly, sympodial initiation of a second germ tube occurred at the apical end of the spore (Plate 3, F & G). Subsequent disarticulation of the initial germ tube typically ensued.

Germination rarely occurred on WA, and only after 72 hours. The characteristic swelling prior to germination was more pronounced than on EC-14 medium. Following 5 days on WA germ tubes up to 5.5 µm had developed. Though infrequent, some conidia swelled appreciably, approaching 40 µm in length and 2.5 µm in basal width, the apical half remaining quite narrow. Even after 10 days germination failed to progress further.

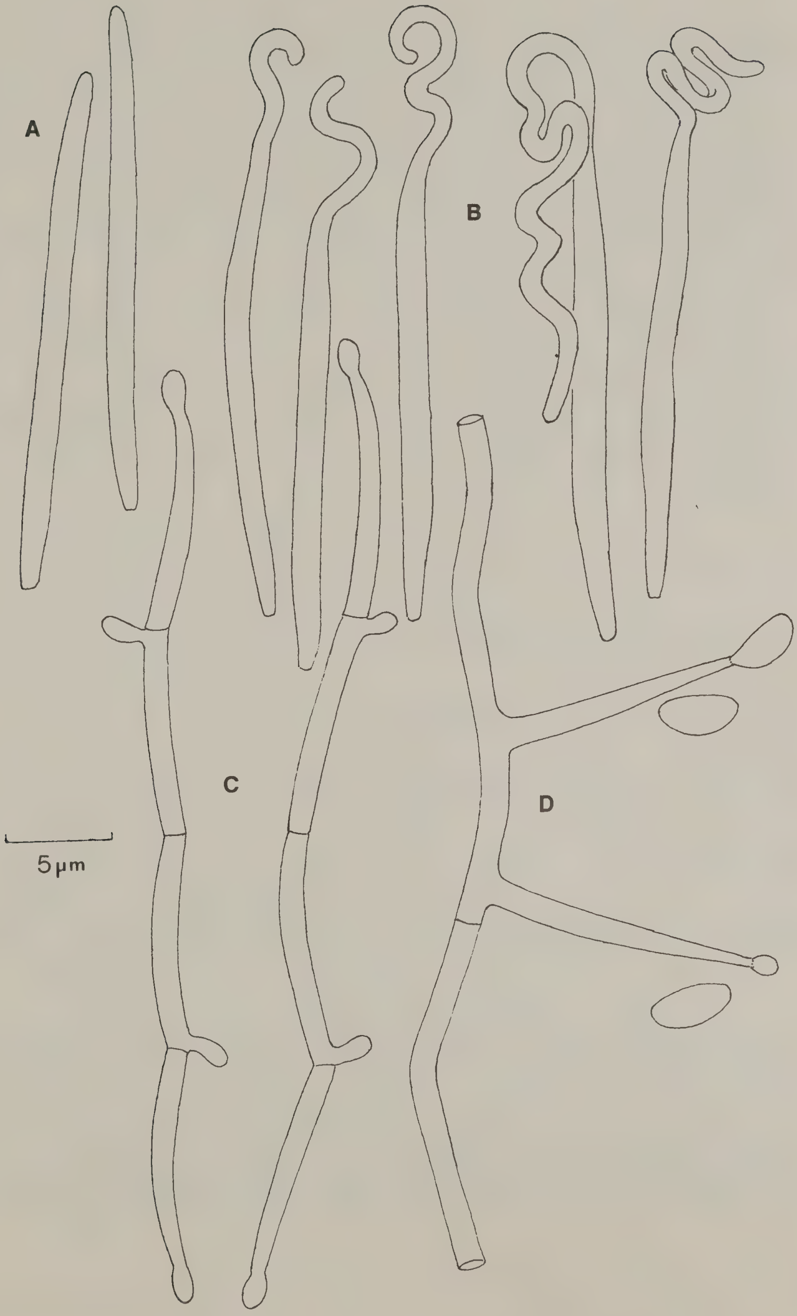
Ascospores.

Ascospores of *Balansia epichloe* disarticulate within the asci, forming one-septate part-spores which are then discharged. Part-spores are broadly filiform with truncate ends, 32 to 46 µm in length (Plate 3, I; Figure 4, A). Although half part-spores seldom separated completely, their partial disarticulation at median septae was a common phenomenon. Germination on EC-14 medium occurred within 24 hours. A germ tube developed from the outer exposed end of each half part-spore, and usually grew sharply to one side or the other (Plate 3, J & K). Since half part-spores typically remained connected, this germination pattern resembled bipolar germination of the part-spore. After 72 hours germ tubes had reached at least 10 to 14 µm in length on WA, and at least 17 µm in length on EC-14. No further development occurred on WA. On EC-14 medium, sympodial initiation of secondary germ tubes, and disarticulation of initial germ tubes followed (Plate 3, L; Figure 4, B).

Myriogenospora atramentosa. Ascospores.

The germination pattern characteristic of ascospores of this species is particularly distinctive. Long, narrow, filiform, aseptate part-spore with acutely tapered ends are discharged from each ascus. Rarely, these part-spores remain joined end-to-end in pairs. Within 48 hours on WA and EC-14 media, part-spores exhibited monopolar germination by the development of a germ tube from a slight apical enlargement. A similar swelling on the other end remained dormant throughout germination, which continued for several days and then ceased. At first germ tubes were distinctly curled, becoming undulate or loosely circinate to somewhat coiled (Plate 2, I-L; Figure 5, B). On EC-14 medium, branching was frequent, each branch continuing the same growth habit.

FIGURE 5. A, *Myriogenospora atramentosa* part-ascospores from nature; B, part-spores germinating; C, germinating ascospores of *Atkinsonella hypoxylon* (after Leuchtmann and Clay, 1989); D, segment of *Epichloe typhina* ascospore showing iterative germination (after Bacon and Hinton, 1988).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5 µm

DISCUSSION

Ascospore and conidial germination peculiarities clearly vary appreciably between the member genera of the Balansieae and, to a lesser extent, between species. It is interesting to note that ascospore germination in the two species of *Balansia* investigated during the course of this study is more closely similar than between these and species of *Atkinsonella*. Rykard *et al.* (1984) questioned the desirability of maintaining *Atkinsonella* and *Balansiopsis* Hohnel as separate genera from *Balansia*. Further information on ascospore germination in additional species of *Balansia* will, perhaps, help resolve that question. As pointed out by Leuchtmann and Clay (1989), disarticulation of seven-septate ascospores into two three-septate part-spores, and the number and location of germ tubes formed subsequently, appears to be unique for the genus *Atkinsonella*. This is certainly different from species of *Balansia* where the released part-spores are one-septate and those of *Myriogenospora* which are aseptate. That the two known species of this genus, *A. hypoxylon* and *A. texensis*, have identical ascospore germination (Leuchtmann and Clay, loc. cit.) indicates that they are closely related. The latter, on morphological grounds alone, was originally classified as *A. hypoxylon* var. *texensis* by Diehl (1950). It was recently recognized as a separate species mainly on the basis of host association, isozyme variation, colony differences *in vitro* and host cross-inoculation incompatibilities (Leuchtmann and Clay, loc. cit.).

The distinctive ascospore discharge and germination characteristics of *Epichloe typhina* and *Myriogenospora atramentosa* are further indicative of the usefulness of this feature in determining relatedness. The single-celled part-spores of the latter and the very different germination morphology are reflective of the genetic distance between *Myriogenospora*, a monotypic genus, and others classified in the tribe Balansieae. The monopolar germination characteristic of each part-spore also indicates this. *Myriogenospora* was not included by Diehl (1950) in the tribe but added by Luttrell and Bacon (1977) despite its considerably different epiphytic habit and ascus morphology. Luttrell and Bacon (loc. cit.) considered the type of germination in *M. atramentosa* to be significant, noting that in species of *Balansia* each cell in the filamentous ascospore may germinate by a coiled germ tube produced from the side of the cell just below the septum. That is, of course, a simplification and generalization for, as indicated in the results noted above, there are variable patterns of ascospore disarticulation, secondary septation, and secondary breaking apart of part-spores, associated with the sequence of germ tube initiation. Germ tubes in *Balansia* do not usually appear to be undulate, circinate or coiled in the manner of those formed from ascospores of *Myriogenospora*.

The swelling of the *Ephelis* conidia of *M. atramentosa* in liquid culture reported and illustrated by Rykard *et al.* (1982) is, interestingly, reminiscent of the morphological changes, described herein, undergone by conidia of *Balansia aristidae* prior to germination. The latter differs, however, in that the swelling occurs at the apex of the conidium only and not at each end, as was noted to occur in *M. atramentosa* by Rykard *et al.* (loc. cit.). The sequence of secondary conidia sympodially produced from the tip of a determinate germ tube in *M. atramentosa* form in essentially the same manner as the primary conidia.

Such sympodial growth is also seen occurring during germination of conidia and ascospores of both *B. aristidae* and *B. epichloe*.

The sequences of events occurring during macroconidial and ascospore germination in *Balansia aristidae* and *B. epichloe* are distinctive for each species and, therefore, of use in their characterization. The considerable degree of difference in ascospore growth pattern, morphology and disarticulation is of particular interest. The secondary septation and the eventual breaking up of the original one-septate part-spore into four separate cells in *B. aristidae* is, to our knowledge, unique in the genus. There is, in this case, a sequence of primary, secondary and tertiary disarticulation of the original ascospores delimited within the asci. Whether such differences exist between other species of the genus remains to be determined. The account by Ullasa (1969) of germination in *Balansia claviceps* in hanging drop cultures is not comparable to the present study because of the differing conditions and less detailed observations. It would be interesting, for example, to investigate if there are differences in regard to germination between *B. aristidae* and *B. strangulans*, two species that are considered close (Diehl, 1950), and likewise between *B. epichloe* and *B. henningsiana* (Moell.) Diehl, two species that are superficially similar, and from time to time have been considered to be the same fungus, but are now recognized as separate and distinct entities. There is reason to believe that, even if all individual species lack clear-cut differences in respect to germination peculiarities, this criterion is nevertheless of some use in indicating relatedness and/or separateness.

ACKNOWLEDGEMENT

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LITERATURE CITED

BACON, C.W. and D.M. HINTON. 1988. Ascosporic iterative germination in *Epichloe typhina*. *Trans. Br. mycol. Soc.* 90: 563-569.

BOOTH, C. 1959. Studies of Pyrenomycetes. IV. *Nectria* (part 1). *Mycol. Pap.* 73: 1-115.

DIEHL, W.W. 1950. *Balansia* and Balansiae in America. Agric. Monograph No. 4, USDA, Washington, D.C. 82 pp.

LEUCHTMANN, A. and K. CLAY. 1989. Morphological, cultural and mating studies in *Atkinsonella*, including *A. texensis*. *Mycologia* 81: 692-701.

LUTTRELL, E.S. and C.W. BACON. 1977. Classification of *Myriogenospora* in the Clavicipitaceae. *Can. J. Bot.* 55: 2090-2097.

MORGAN-JONES, G., R.A. PHELPS and J.F. WHITE, JR. 1992. Systematic and biological studies in the Balansieae. I. Prologue. *Mycotaxon* 43: 401-415.

ROSSMAN, A.Y. 1983. The phragmosporous species of *Nectria* and related genera. *Mycol. Pap.* 150: 1-164.

RYKARD, D.M., E.S. LUTTRELL and C.W. BACON. 1982. Development of the conidial state of *Myriogenospora atramentosa*. *Mycologia* 74: 648-654.

ULLASA, B.A. 1969. *Balansia claviceps* in artificial culture. *Mycologia* 61: 572-579.

MYCOTAXON

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Chaetospermum chaetosporum (Coelomycetes). First record from the Iberian Peninsula

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Abstract. *Chaetospermum chaetosporum* (Pat.) Smith & Ramsb. was encountered on graminicolous leaves and sheaths with small distorted areas, in the Tibidabo mountain, Catalonia. The conidiomatal structures of the fungus showed an evident resemblance to gelatinous sporodochia. This is the first record of the above mentioned taxa in the Iberian Peninsula.

Key words: Coelomycetes, *Chaetospermum*, *C. chaetosporum*.

In July 1990 several graminicolous decaying plants were collected in the Tibidabo mountain, near the city of Barcelona (Catalonia, Spain), showing coloured, slightly thickened, distorted areas on the leaves and sheaths. A closer examination of the lesions revealed the presence of orange – yellow structures, gelatinous to the touch, resembling groups of sporodochia. The microscopic preparations made from such crushed structures showed abundant subcylindric conidia with bipolar appendages characteristic of the genus *Chaetospermum* Sacc. The sporodochium – like bodies and the *Chaetospermum* conidia were seen in subsequent collections of similar lesions on leaves of decaying Gramineae growing near the same place. Some conidia of other fungi (mainly *Alternaria* and *Cladosporium* species), together with those of *Chaetospermum*, were observed eventually in the slides, as well as some few conidia of *Drechslera* (probably *D. victoriae* (Meehan & Murphy) Subramanian & Jai).

Since no published reports have been found concerning the presence of *Chaetospermum* species in the Iberian Peninsula, the description of the fungus encountered in the Tibidabo is herein presented.

Material and Methods

Collections studied. The material studied consisted of decaying grass leaves and sheaths showing small distorted areas with minute sporodochium–like conidiomata. The material was collected in the Tibidabo mountain, Serra de Collserola (500 m altitude), near Barcelona, Catalonia, Spain, the 1st, 7th and 8th July 1990, a month with no rains, that followed a dry period.

Microscopic preparations and examination. The conidiomata were removed from the plant substrates with sterilized needles and mounted onto glass microscope slides in lactophenol slightly stained with safranin. Preparations fro, thirteen different collections were sealed with a nailpolish double coat and labeled EE. 90, 30–42. Microscopic examinations were made using a Leitz Diaplan microscope and 1,000 magnifications by oil–immersion, bright field, phase–contrast and the Nomarski interference optic systems. Micrographs were taken with a Nikon F–610 camera and Ilford Pan F, 50 ISO film.

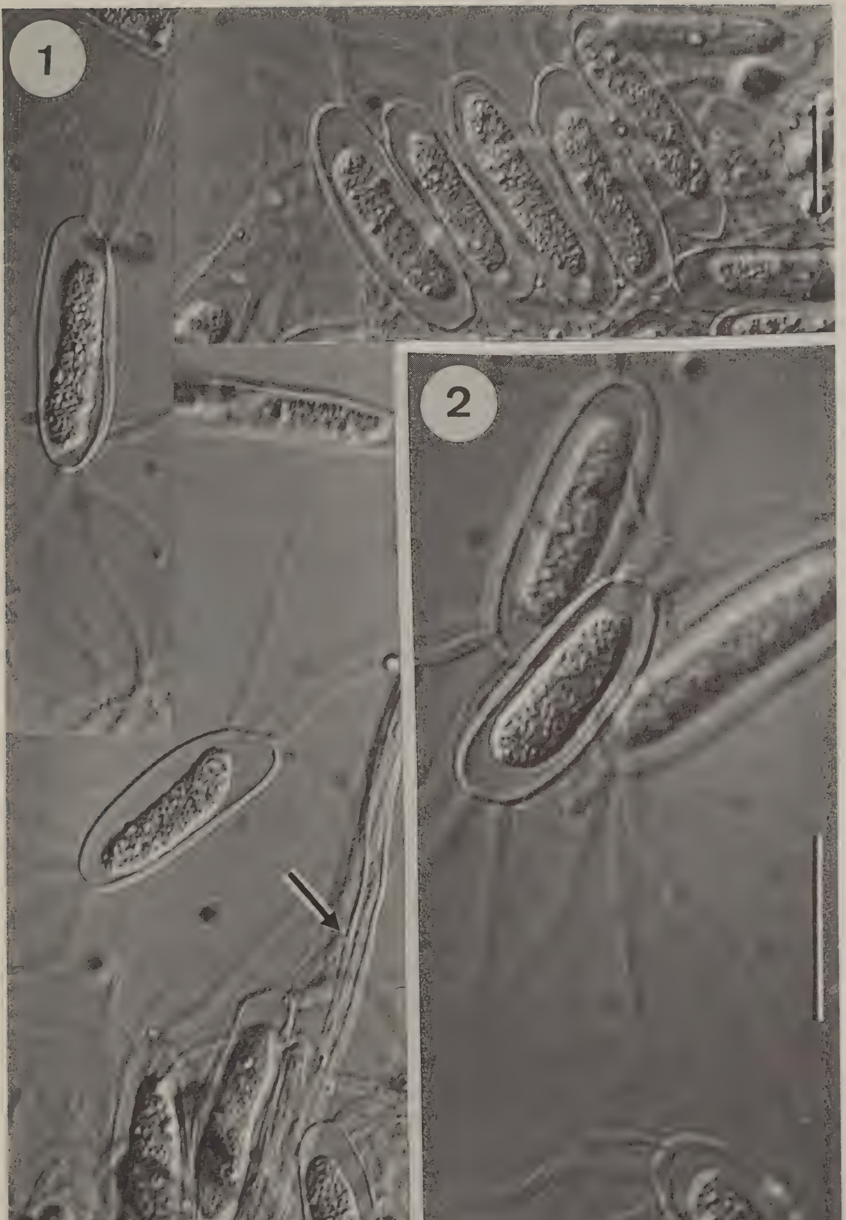
Slides labeled EE. 90. 30 and 33 were deposited in the Mycological Herbarium BCC (University of Barcelona).

Results

The morphologic features of the fungus encontered in the Tibidabo mountain were the following:

Conidiomata consisting of orange–yellow, sessile, gelatinous, mostly aggregate and roughly spherical structures more similar to sporodochia than to typical acervula. *Conidiophores* constituted by tufts of hyaline hyphae, mostly 30–40 x 1.5–2 µm (Fig. 1, arrowed), with terminal or lateral conidiogenous cells, swelling at their tips to give rise the conidia. *Conidia* elongate–cylindrical, straight to slightly bent smooth–walled, hyaline, (15–) 30–35 (–45) x (5–) 7.5 (–10) µm, aseptate, with granular contents (Figs. 1 and 2), with the apices irregularly obtuse or sometimes almost truncate and bearing three to six terminal or subterminal appendages. *Appendages* filiform, flexuous, not branched, not septate, 1 µm width, generally as long as the conidium body, or slightly shorter; with no protoplasmatic continuity with the conidium body when the internal contents retracts.

Figs. 1 and 2. *Chaetospermum chaetosporum* (Pat.) Smith & Ramsb. (Mycol. BCC Herbarium Nº EE. 90. 30). Conidiophores (arrowed) and conidia showing the granular protoplasm conspicuously retracted (separated) from the cell–wall, and the apical and subapical insertion of the appendages. Scale bars = 10 µm.


1
2

Discussion

The several generic names that have been given to the fungi now gathered in the genus *Chaetospermum* reflect the views of their authors concerning the conidiomatal structure of these fungi. The conidiomata, initially roughly spherical and later rupturing irregularly, show such a variation in morphology that the species have been placed in the Tuberculariales, Melanconiales and Sphaeropsidales. Patouillard (1888) considered a sporodochium the conidiomata of the fungus that he described as *Tubercularia chaetospora*, for which Saccardo (1892) erected the genus *Chaetospermum*, with the following short diagnosis: *Sporodochia gelatinosa. Sporophora ramosa. Conidia ovoidea, hyalina, utrinque 7 – 8 setosa*. Later on the conidiomata of *Chaetospermum* were again referred to as sporodochia (Smith & Rambsbottom, 1913; Agnihothrudu, 1962). However, the *Chaetospermum* conidioma was considered essentially a pycnidium by other authors (Höhnel, 1924; de Fonseka, 1960; Nag Raj & Kendrick, 1972), while after Sutton (1980) it is acervular. The conidiomatal structures of the fungus collected in the Tibidabo evidently grade into sporodochial conidiomata.

Sutton (1980) put into synonymy with *Chaetospermum* the genera *Ciliospora* Zimmerman, *Mastigonema* Speg., *Entomopatella* Petrak, and *Chaetospermella* Naumov, as he had discussed early (Sutton, 1977). Of the five *Chaetospermum* species keyed by Agnihothrudu (1962), Sutton (1980) tentatively recognized only three, mainly based on conidium size. This author maintained *C. gelatinosum* Petch in the genus, although recognized that the conidia are much thicker – walled than in the other accepted taxa and the appendages are very thin, perhaps not "cellular" in origin.

In Tab. 1 the main morphometric characters of the fungus collected in the Tibidabo have been compared with those of *C. chaetosporum*, the type species of the genus, and other congeneric taxa. It can be concluded that the *Chaetospermum* structures found on the plants collected in the Tibidabo fit well with the morphology and dimensions of *C. chaetosporum*. It could be only remarked here that septate spores like those reported and illustrated by de Fonseka (1960) from 3 – 4 month – old conidiomata were not seen in our collections, although the retraction of the conidium body protoplasm observed in some slides could indicate that the fructifications were quite old. The retraction was not considered a manipulation artefact, since the phenomenon was observed in water preparations as well as in the lactophenol – mounted slides.

Much attention was paid in this study to the appendages of the conidia since many species of the Coelomycetes show similar structures. Their features have been considered by Sutton & Sellar (1966) and Sutton (1968, 1973) of great importance. Sutton's criteria have been sustained by Pirozinski & Shoemaker (1971), Nag Raj (1981, 1988) and others. According to these criteria the conidial appendages of the fungus found in the Tibidabo must be considered of "cellular" origin.

Tab. 1. Morphometric features of the specimens of *Chaetospermum chaetosporum* collected in the Tibidabo, compared with those of other related taxa

Taxa	Conidiophores	Conidia	Appendages (numer and size)	References
Chaetospermum from Tibidabo	30-40x1.5-2 µm	thin-walled 25-35 (15-45)x 5-7 (-10) µm	3-6; up to 45 µm long	
C. chaetosporum (Pat.) Smith & Ramsb.		38-43x8-10 µm	7-8; as conidium length	Smith & Ramsb., 1913
C. chaetosporum (Pat.) Smith & Ramsb.		thin walled 28-53x13-15 µm	3-11; 35-68x1 µm	de Fonseka, 1960
C. chaetosporum (Pat.) Smith & Ramsb.	10-30x2 µm	26-45x8-15 µm	3-10; up to 45 µm long	Sutton, 1980
= *Tubercularia chaetospora* Pat.		38-43x8-10 µm		Pat., 1888
= *C. tubercularioides* Sacc.		38-48x8-10 µm	7-8	Saccardo, 1892
C. carneum Tassi	up to 12x1-2 µm	16-26x3-4 (-6) µm	5-9; up to 14-18x1 µm	Sutton, 1980
= *C. camelliae* Agnih.	ultimate laterals up to 12x1-2 µm	16-22 (-26)x 3-4 (-6) µm	5-9; up to 22 µm long	Agnih. 1962
C. gelatinosum Petch	30x3 µm	thick-walled, 36-44x16-21 µm	6-12; up to 80 µm long	Sutton, 1980

C. chaetospermum appears not to be a common fungus in the Iberian Peninsula. Records of this species or other related taxa are not found in the literature. Since July 1990 we were not able to collect again this species.

C. chaetosporum has been reported on stems, twigs and leaves of a variety of plants belonging to very different genera, but no studies have been found emphasizing this organism as a pathogenic one. However, the lesions observed on the leaves and sheaths from which the fungus was recovered in the present study were similar to those attributed by Sprague (1950) to *Dilophospora alopecuri* (Fr.) Fr. Controlled inoculation tests of healthy plants with *C. chaetosporum* should dilucidate the questions related to its pathogenicity, specially taking into account that conidia of other fungi were found in the samples examined.

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References

AGNIHOTHRUDU, V. 1962. Notes on fungi from North–East India X. *Chaetospermum camelliae* sp. nov. on tea (*Camellia sinensis* (L.) O. Küntze). *Mycopathologia et Mycologia Applicata* 16, 113–116.

FONSEKA, R.N. de 1960. The morphology of *Chaetospermum chaetosporum*. *Transactions of the British mycological Society* 43, 631–636.

HÖHNEL, F. von 1924. Über die Gattung *Chaetospermum* Sacc. *Mitt. bot. Lab. techn.* Hochsch. Wien, 3, 86–88.

NAG RAJ, T.R. 1981. Coelomycete systematics. *In* The biology of conidial fungi. Vol. I. *Edited by* G.T. Cole & B. Kendrick. Academic Press: New York.

NAG RAJ, T.R. 1988. Genera coelomycetarum. XXIV. *Chithramia* anamorph gen. nov. *Canadian Journal of Botany* 66, 903–906.

NAG RAJ, T.R. & KENDRICK, W.B. 1972. Genera Coelomycetarum III. *Pestalozziella*. *Canadian Journal of Botany* 50, 607 – 617.

PATOUILLARD, M.N. 1888. Note sur une Tuberculariee graminicole. *Bulletin de la Société Mycologique de France* 4, 39 – 40.

PIROZYNSKI, K.A. & SHOEMAKER, R.A. 1971. Some Coelomycetes with appendaged conidia. *Canadian Journal of Botany* 49, 529 – 541.

SACCARDO, P.A. 1892. Sylloge Fungorum 10 (p. 706). Padua.

SMITH, A.L. & RAMSBOTTOM, J. 1913. New or rare fungi. *Transactions of the British mycological Society* 4, 318 – 330 (p. 328).

SPRAGUE, R. 1950. Diseases of cereals and grasses in North America (Fungi, except smuts and rusts). Ronald Press: New York.

SUTTON, B.C. 1968. *Kellermania* and its generic segregates. *Canadian Journal of Botany* 46, 181 – 196.

SUTTON, B.C. 1973. Coelomycetes. *In* the Fungi. An Advanced Treatise. Vol. IV A. *Edited by* G.C. Ainsworth, F.K. Sparrow & A.S. Sussman. Academic Press: New York.

SUTTON, B.C. 1977. Coelomycetes VI. Nomenclature of generic names proposed for Coelomycetes. *Mycological Papers* 141, 1 – 253.

SUTTON, B.C. 1980. The Coelomycetes. Fungi Imperfecti with Pycnidia Acervuli and Stromata. Commonwealth Mycological Institute: England.

SUTTON, B.C. & SELLAR, P.W. 1966. *Toxosporiopsis* n. gen., an unusual member of the Melanconiales. *Canadian Journal of Botany* 44, 1505 – 1513.

MYCOTAXON

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LECTOTYPIFICATION OF OPHIOBOLUS TRICHELLUS (DOTHIDEALES, ASCOMYCETES)

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A lectotype specimen is designated for *Ophiobolus trichellus* SACC., BOMM. & ROUSS. The species, recently placed in *Tubeufia* by SCHEUER (1991), is briefly described and illustrated.

Key words: *Tubeufia trichella*, taxonomy.

SCHEUER (1991: 814) has recently published a new combination of *Ophiobolus trichellus* SACC., BOMM. & ROUSS., *Tubeufia trichella*. Although the British material examined agrees with the original description in every respect, the new combination was somewhat doubtful, because no type material of *Ophiobolus trichellus* had been available at that time. A quite satisfactory syntype specimen from Knocke (Belgium) could be located in PAD. It agrees with the protologue and with the British material studied and illustrated by SCHEUER (1991). No specimen from Oostende (Belgium), the second locality given by the authors in the protologue (in BOMMER & ROUSSEAU 1890: 259), could so far be found in any herbarium. The syntype specimen in BR (Sur les feuilles d'*Ammophila arenaria*, [Belgium,] Knocke, Août 1890, leg. M. ROUSSEAU) consists only of a small leaf fragment bearing no ascomata of *Ophiobolus trichellus*. Nevertheless, because of the two localities given in the protologue, a lectotype must be designated.

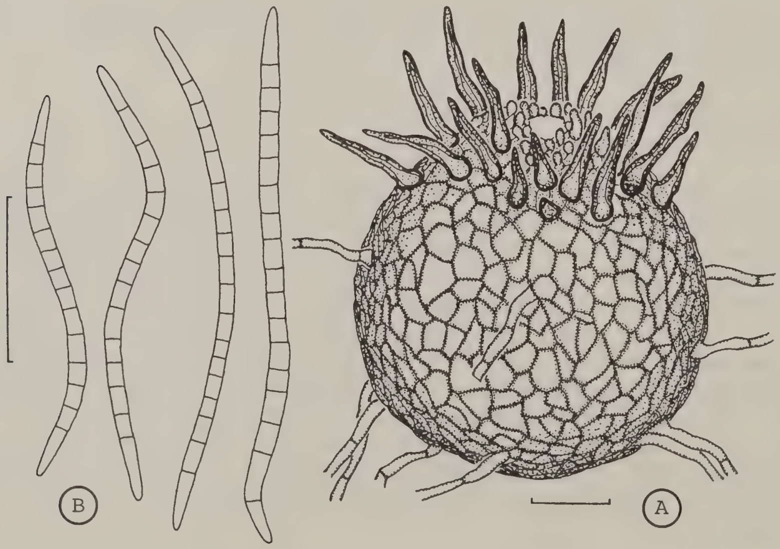
Ophiobolus trichellus P. A. SACCARDO, BOMMER & ROUSSEAU
in BOMMER & ROUSSEAU, *Bull. soc. roy. bot. Belgique* 29: 259 (1890), later cited erroneously as '*O. trichellus* BOMM., ROUSS. & SACC.' in Syll. Fung. **9**: 934 (1891).

≡ ***Ophiochaeta trichella*** (SACC., BOMM. & ROUSS.) SACC.,
Syll. Fung. **11**: 352 (1895).

≡ ***Tubeufia trichella*** (SACC., BOMM. & ROUSS.) SCHEUER,
Mycol. Res. **95**(7): 815 (1991).

Ascomata (Pseudoperithecia) ± scattered on dead leaves of *Ammophila arenaria* (L.) LINK, usually epiphyllous, nesting among the leaf hairs, brown, ± globose, ca. 100 μm in diam., with a fringe of dark brown, simple setae around the ostiole. No branched setae have been found in the lectotype material. Setae ca. 20–40 μm in length, tapering from the base, but always rather torulose and irregular in outline, thick–walled, usually non–septate. The ostiole is surrounded by small, knob–like peridial cells. Peridium in surface view composed of irregular, angular cells up to ca. 8 μm in diam., consisting of 3 – 5 layers of slightly flattened cells. Pseudoparaphyses present in mature loculi, ca 1.5–2 μm thick. Asci bitunicate, ± cylindrical, 45–66 x 10–15 μm (SACCARDO, BOMMER & ROUSSEAU 1890), 8–spored. Ascospores hyaline, flexuous, cylindric–filiform, ca. 48–65 x 2.5 μm, 14–16–(?18–)septate, guttulate. The ascospores are usually coiled in the ascus, before the ascus expands at maturity.

LECTOTYPUS designated here: À la face inférieure des feuilles du *Psamma arenaria* [=Ammophila arenaria], [Belgium,] Knocke; ex Herb. E. BOMMER & M. ROUSSEAU (Herbarium Mycologicum P. A. SACCARDO, 2729, **PAD**).



Lectotype of *Ophiobolus trichellus*: (A) Ascoma. (B) Ascospores (lactophenol permanent slide). – Bars = 20 μm.

This material differs only very slightly from the British collections studied and illustrated by SCHEUER (1991: 814, 815). No branched setae have been found in the lectotype, but in some (not all!) of the British collections. In addition, apparently some of the ascospores of the two ascomata mounted from the lectotype have more septa (up to 18?) than those of British material (up to 15).

Thanks to Dr. Sergio CHIESA (Padova) for his help in tracing the type specimen in PAD, and to PD. Dr. Orlando PETRINI (ETH Zürich) for acting as pre–submission reviewer.

References

BOMMER, E. & M. ROUSSEAU 1890. Contributions à la flore mycologique de Belgique. – *Bulletin de la societé royale de botanique de Belgique* **29**: 205–302.

SCHEUER, Ch. 1991. *Taphrophila* (Dothideales: Tubeufiaceae) and two new species of *Tubeufia* with dark setae. – *Mycological Research* **95**(7): 811–816.

MYCOTAXON

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TAXOMYCES ANDREANAE, A PROPOSED NEW TAXON FOR A BULBILLIFEROUS HYPHOMYCETE ASSOCIATED WITH PACIFIC YEW (TAXUS BREVIFOLIA)

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ABSTRACT

Taxomyces andreanae is described as a novel endophytic fungus associated with the inner bark of *Taxus brevifolia* Nutt. (Pacific yew). This fungus has small septate hyphae which average 1.2 µm and large septate hyphae which average 3.75 µm in diameter. Hyphal cells of this fungus are multinucleate. It characteristically forms clumps of loosely constructed cells (bulbil-like). These clumps are of various shapes and sizes typically ranging from ca. 5x5 to 16x30 µm in diameter and length. The nucleated cells in these clumps average about 1.5x2.5 µm and appear to be loosely packed in the bulbil and are incapable of germination. This fungus grows rapidly on many common laboratory media, covering the plates with its mycelium in 3-4 days. It lacks clamp connections, and dolipore septations. Its telemorph is unknown.

INTRODUCTION

The Pacific yew (*Taxus brevifolia* Nutt.) is the primary source of taxol, a promising anticancer drug isolated from the inner bark of this tree (1,2). In a search for microbes that may influence the production and/or fate of taxol (and related taxanes)in this tree, we have made a concerted effort to isolate and identify parasitic and endophytic microbes associated with it. In the present report we describe a novel endophytic hyphomycete, *Taxomyces andreanae*, that was isolated exclusively from the inner bark on small limbs of a specific yew tree in Northern Montana.

MATERIALS AND METHODS

The fungus was isolated from the upper limbs of a shrub-like Pacific yew tree growing as undercover in a mature, undisturbed cedar forest in Flathead County, Montana. Small limbs (0.5 - 1.0 cm) were surface treated with 70% ethanol. The outer bark was peeled back and pieces of the white inner bark (phloem/cambium) were aseptically removed and placed on H_2O agar. Hyphal tips of fungi growing from the pieces of the plant were placed on mycological agar and fungal growth was enhanced. Subsequent attempts to isolate the fungus from other sites in Montana, Idaho, Oregon and Washington were unsuccessful.

The growth pattern of the fungus was studied on other additional plant species. Leaf, stem, and bark samples of various plant species growing near the tree from which this fungus was obtained were collected near the Hungry Horse dam site on the Flathead National Forest. Small pieces (0.5 - 2 cm) of leaves, stems and bark of these species were placed over 4 layers of cheesecloth, thoroughly dampened, and autoclaved. Agar blocks (1.0x1.0 cm) supporting fungal growth were then placed on the sterilized plant material and fungal growth observed and measured after 1 week.

The growth of the fungus was measured daily after placement of 0.5x0.5 cm agar blocks on standard freshly prepared agar media plates (Difco) eg. potato dextrose broth agar, nutrient agar, oatmeal agar, cornmeal agar, lima bean agar, water agar, and malt agar.

Agar blocks having mycelia and bulbil-like structures were fixed and dehydrated as for transmission and scanning electron microscopy (SEM) (3,4,5,6). For SEM, the material was then critical point dried, gold coated and sputter coated, and observed with a JEOL 840A scanning electron microscope. Fungal structures were measured on SEM micrographs after critical point drying of tissues. This drying procedure causes some shrinkage of biological structures (ca. 10%) which means that they are probably slightly larger, and the clumps of cells more tightly packed when in the living state.

Nuclei were stained with the 4,6 diamidino-2-phenylindole reagent (5μg/ml of 20% ethanol) and observed under UV at 365 nm.

RESULTS AND DISCUSSION

Taxonomic Treatment and Description

Taxomyces andreanae Strobel, Stierle and Hess gen. et sp. nov. (Figs. 1-6).

Fungus endophyticus e cortice interiora Taxo brevifolo Nutt.; hyphae dimporphae -- parvae 1.25 μm et magnae ca 3.75 μm latae et longae; bulbilus cellularum ca 1.25x2.5 μm et laxe contiguus et apparenter non germinans; mycelium celiter crescens, hyphis fibulis nullis et doliporis septis nullis; telemorphus ignotus.

Mycelium superficial, composed of a network of highly branched, septate, multinucleate, usually hyaline, smooth walled hyphae. Smaller hyphal cells average 1.25 μm in diameter. Larger cells average 3.75 μm in diameter (Figs. 1-2). Cells are budded from fructigenous hyphae forming clumps which vary enormously in shape from spherical to ovoid to longiform and in size from 5x5 μm in diameter (for spherical bulbils) to 16 - 30 μm in length (for elongate bulbils). Bulbil cells remaining colorless. The cells seem to be loosely packed in the bulbil and are ovoid ca. 1.5x2.5 μm and are never observed to germinate.

The "clumps" of cells in Fig. 2 and 3 are not located on sterigmata, but seem to arise by a "budding process" from hyphal pores (Fig. 3). The number of cells in each clump varies widely (Fig. 2 & 3). We have referred to these "clumps" as bulbils after the broad definition of deBary (7), that is, "small pluricellular bodies incapable of germination". In *T. andreanae*, the cells of the bulbils, unlike most bulbilliferous fungi, appear to be loosely packed, but nevertheless connected with fibrous material (Figs. 3,6). These clumps of cells might also be considered as conidial masses but since germination has never been observed (in sterile H_2O and nutrient broth), the clumps of cells seem to better fit the broad description of a bulbil. Furthermore, transmission electron microscopic examination of these bulbil cells reveals that they are engorged with cytoplasmic structures including lipid bodies and each has a nucleus (Figs. 5,6)(8,9). They also possess a bilayered cell wall

(Figs. 5,6). Nevertheless, these bulbils differ from the bulbils of other standard bulbilliferous fungi by lacking pigmentation, certain sclerotial-like qualities (outer rind-like cells and inner swollen cells) and in the manner of their formation (10).

T. andreanae may be related to *Cladorrhinum spp.* by virtue of certain conidial and hyphal characteristics (11). However, our SEM and culture observations made on the type species - *Cladorrhinum foecundissimum* revealed the absence of bulbils, the presence of spherical conidia, and the presence of small, numerous phialid-like structures on the hyphae, presumably from which the spores are budded (11). Furthermore, *C. foecundissimum* and related species are heavily pigmented (green-black colonies) and are commonly isolated from soil and dung sources. In addition, *T. andreanae* was inhibitory to *C. foecundissimum.* These findings are all in sharp contrast to the descriptions given in this report of *T. andreanae.*

Type species: *Taxomyces andreanae* Strobel, Stierle, & Hess.

Holotypus: Based on material taken from the bark of *Taxus brevifolia* Nutt., collected by Andrea and Don Stierle, August, 1991, in Flathead County, Montana, USA. Agar slants containing the type culture are deposited with the MSU mycological collection, D. E. Mathre, Department of Plant Pathology, Montana State University - col. no. 738. Duplicate cultures are deposited at the CBS, Baarn, Netherlands; International Depository Authority, CBS 279.92. Dried specimens are on deposit at the Farlow Herbarium, Harvard University (FH).

Etymology

The source tree of the fungus is Taxus, hence the genus designation - *Taxomyces*. The species name, *Taxomyces andreanae*, is in honor of Andrea Stierle. Andrea is a colleague, research associate and dedicated scientist. She and her husband, Don Stierle, were the people who originally isolated this organism.

Cultural Characterization

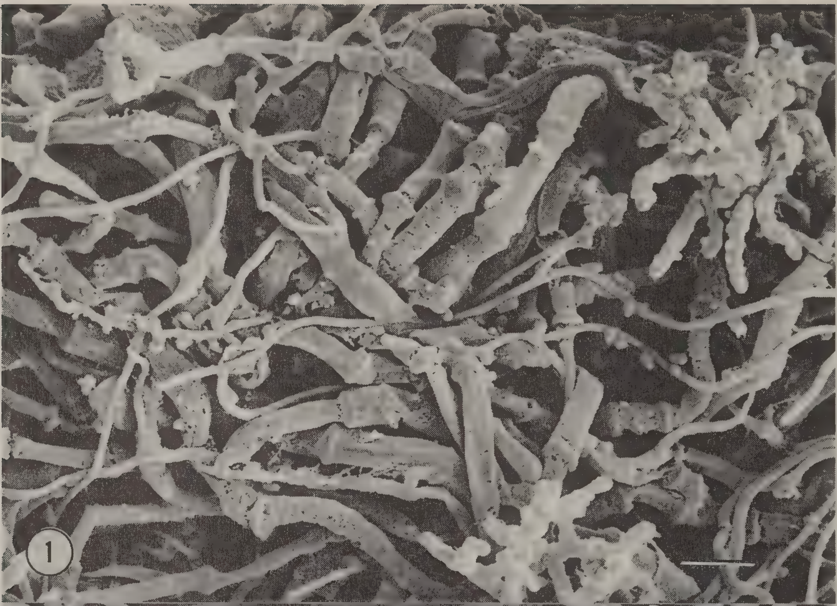
When an agar plug of inoculum was placed in the center of most freshly prepared agar plates enriched with various nutrients it grew so rapidly that it reached the edge of the plate in 3 days (corn meal agar, lima bean agar, nutrient agar, malt agar, oatmeal agar). Bulbils did not form on any of these media up to 6 days after inoculation. However bulbils were noticed on the inoculum piece on the corn meal agar after 6 days. Some bulbils were noticed at the edges of the malt agar plate 7 days after inoculation. Numerous fluffy aerial mycelia were especially observed on malt agar and after 6-7 days the mycelium on the malt agar developed a deep reddish-brown coloration and a thick mycelial mat.

When the fungus was placed on the autoclaved leaves, fragments of small limbs, and bark taken from various tree species located in the geographical area of *Taxus brevifolia*, the best mycelial growth and bulbil formation occurred on Pacific yew (Table 1, Fig. 4), followed by River birch (*Betula nigra*) (Table 1). In contrast, there was no growth on, or bulbil formation on, *Larix occidentalis*, or *Tsuga heterophylla*, (Table 1). Other species differentially supported weak fungal growth and light bulbil formation, eg. *Pinus monticola, Picea engelmanni* (Table 1). These observations suggest the likelihood that some host preference of *Taxomyces andreanae* exists in nature and that it would be unlikely to be found in and on many species other than *Taxus* or *Betula*. This organism appears to be a saprophyte or endophyte with the latter preferred since it was found in association with living tissue. After one year it was still possible to recover the organism from the inner bark of the source tree. There is no evident gross pathology of this host tree. Furthermore, attempts, using agar blocks infested with *T. andreanae* placed under the bark of yew also failed to cause any disease manifestation.

We also noted that the thicker hyphae ca. 3.75 μm in dia, were the ones that typically extended the mycelial mat from one object (leaf or limb fragment or agar block) to another. These might be considered "exploratory hyphae". Careful study of the cultural, mycelial and bulbil characteristics in comparison to other bulbilliferous fungi nicely demonstrated the uniqueness of *Taxomyces andreanae* (10).

ACKNOWLEDGEMENTS

We acknowledge the financial assistance of the National Science Foundation and the Montana Agricultural Experiment Station. Appreciation is also expressed to the Hungry Horse Ranger District of the Flathead National Forest and the Superintendent of Glacier National Park. We also acknowledge discussions with Dr. Amy Rossman, ARS, USDA; Dr. Don Mathre and Gene Ford of Montana State Univesity; and Dr. Ed Butler, University of California, Davis. The description was rewritten in taxonomic format and translated by S. L. Welsh of Brigham Young University. The authors appreciate the help of Ms. Pam Berger in typing and laying out this manuscript.



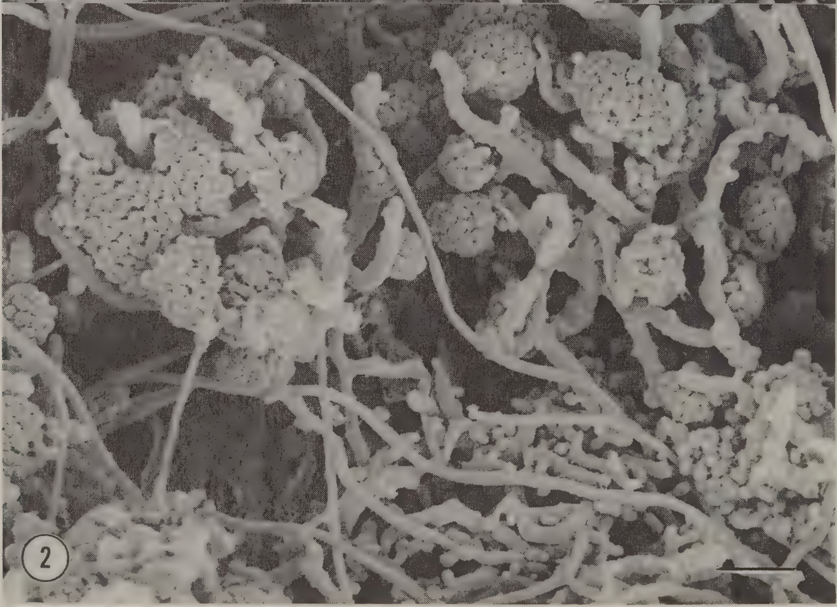
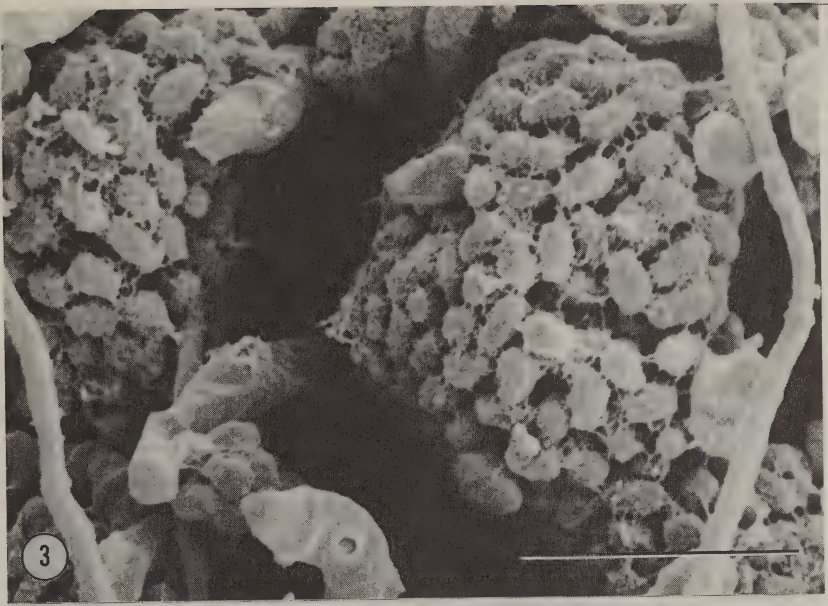


Fig. 1. A scanning electron micrograph of hyphae and fructigenous hyphae of *T. andreanae*. Bar=10 μm.

Fig. 2. A scanning electron micrograph of a series of various shaped bulbils of *T. andreanae*. Bar=10 μm.



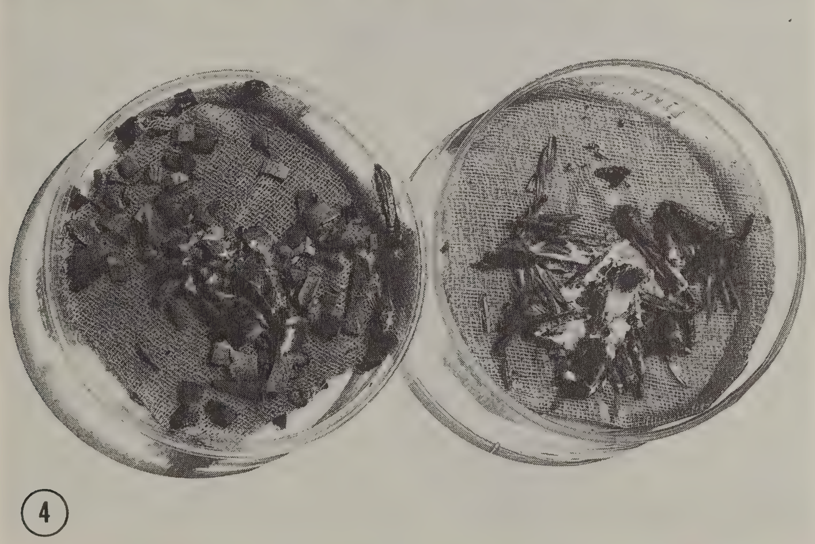
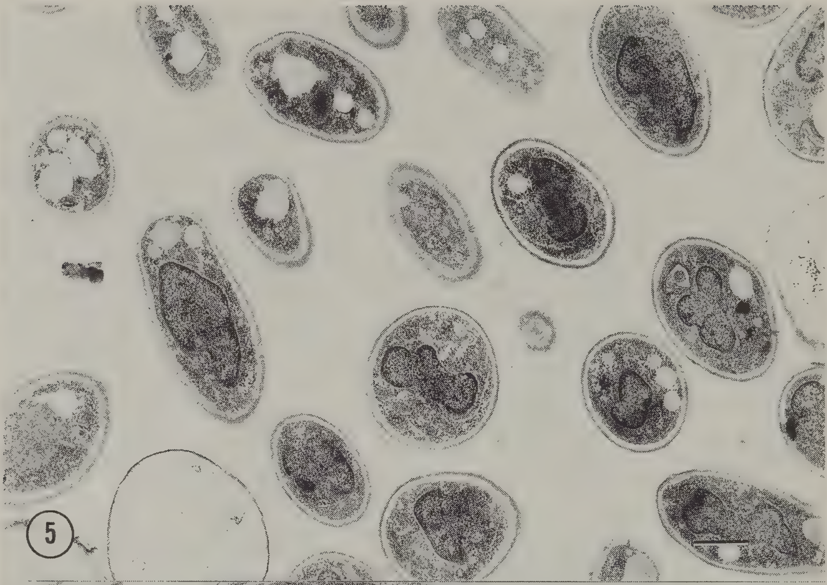


Fig. 3. A scanning electron micrograph of a single bulbil of *T. andreanae* illustrating the organization of the cells of the bulbil. Bar=10 μm.

Fig. 4. Growth of *T. andreanae* on the inner bark of Pacific yew (left) and growth and bulbil formation on the leaves and small limb fragments of *T. andreanae* (right).



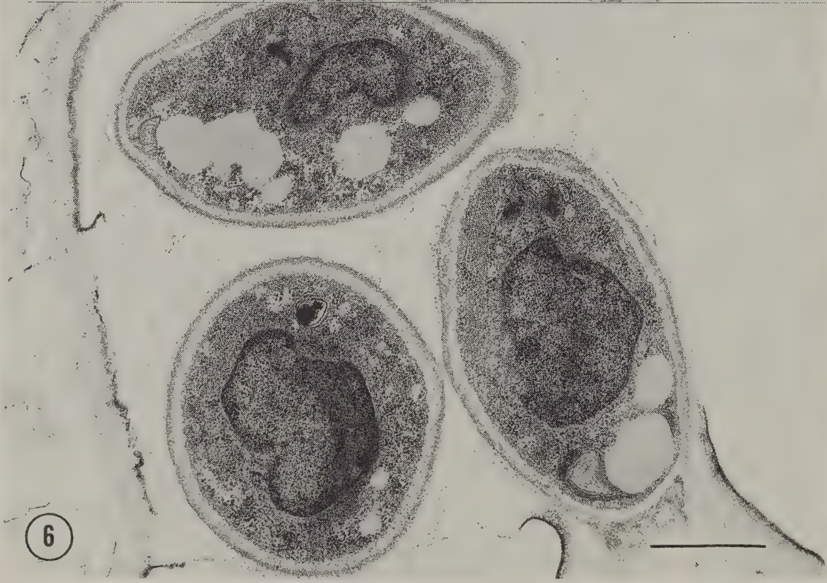


Fig. 5 Transmission electron micrograph of bulbil cells of *T. andreanae* illustrating a dense cytoplasm in each cell. Bar=1 μm.

Fig. 6 Transmission electron micrograph of *T. andreanae* bulbil cells at a higher magnification. Note that the cell wall has two distinct layers, and the fiberous material between the cells. Bar=1 μm.

Table 1. Growth and bulbil formation of *Taxomyces andreanae* on various tree species normally growing in the vicinity of *Taxus brevifolia*. All observations were recorded 1 week after inoculation with a 1.0x1.0 agar block supporting fungal growth.

Plant Species	Av growth from edge of agar block (cm)		Formation of bulbils*	
	Twigs/leaves	Bark	Twigs/leaves	Bark
Taxus brevifolia Nutt. Pacific Yew	2.0	0.25-0.5	heavy	heavy
Betula nigra L. River Birch	1.0	0.75	heavy	moderate
Pinus monticola Dougl. Western white pine	0.1	0.2	light	light
Tsuga heterophylla Rafn Sarg. Western hemlock	0.0	0.1	none	none
Pseudotsuga taxifolia (Poir) Britt. Douglas fir	0.1	0	none	none
Thuja plicata Donn. Western Red Cedar	0.5	0.5	light to moderate	heavy
Picea engelmanni Parry exEngelm. Engelmann spruce	0.1	0	moderate	none
Larix occidentalis Nutt. Western larch	0	0	none	none

*Bulbil formation is given in terms of heavy (completely covering the area where mycelium is growing) to moderate, to light (little or sparce bulbil formation).

REFERENCES

1) WANI, M. C., H. L. TAYLOR, M. E. WALL, P. COGGON, and A. T. McPHAIL. 1971. Plant antitumor agents, VI. The isolation and structure of taxol, a novel antileukemic and antitumor agent from *Taxus brevifolia*. J. Am. Chem. 93:2325-2327.
2) ROWINSKY, E. K., L. A. CAZANAVE, and F. C. DONEHOWER. 1990. Taxol: a novel investigational antimicrotuble agent. J. Natl. Cancer. Inst. 82:1247-1259.
3) UPADHYAY, R., D. KENFIELD, G. A. STROBEL, and W. M. HESS. 1991. *Ascochyta cypericola* causing leaf blight of purple nutsedge (*Cyperus rotundus*). Can. J. Bot. 69:797-802.
4) HESS, W. M. 1966. Fixation and staining of fungus hyphae and host plant root tissues for electron microscopy. Stain Technol. 41:27-35.
5) REYNOLDS, E. S. 1963. The use of lead citrate at high pH as an electron opaque stain in electron microscopy. J. Cell Biol. 17:208-212.
6) SPURR, A. R. 1969. A low viscosity epoxy resin embedding medium for electron microscopy. J. Ultrastruct. Res. 26:31-43.
7) DeBARY, A. 1887. Comparative morphology and biology of the fungi, mycetozoa and bacteria. (English translation). Clarendon Press, Oxford.

8) WEBER, D. J. and W. M. HESS. 1975. Diverse Spores of Fungi IN Spores Vol VI. Am. Soc. of Microbiol. p. 97-111.
9) HESS, W. M. 1981. Fungal Organelles and Other Cell Structures IN The Fungal Spore Morphogenetic Controls, G. Turian and H. R. Hohl (eds) Academic Press, N.Y. pp 21-41.
10) WERESUB, L. K., and P. M. LeCLAIR. 1971. On *Papulaspora* and bulbilliferous basidiomycetes *Burgoa* and *Minimedusa*. Can. J. Bot. 49:2203-2213.
11) COMPENDIUM OF SOIL FUNGI. 1980. *Cladorrhinum* (Sacc and Marchal), [K. H. Domsch, W. Gams and T-H Anderson eds.] Academic Press, N.Y.

MYCOTAXON

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TWO NEW SOUTH AMERICAN SPECIES OF CORTICIACEAE (BASIDIOMYCETES) WITH AMYLOID SPORES

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Abstract

Two new South American species of Corticiaceae (Basidiomycetes), are described: Amyloathelia aspera Hjortst. & Ryv., with asperulate spores from Chile and Aleurodiscus exasperatus Hjortst. & Ryv. from Brazil.

Amyloathelia aspera Hjortst.& Ryv. sp.nov. Fig. 1.
Basidioma resupinatum, effusum, laxe adnatum, tenue, pelliculare.
Hymenophorum leve, album vel cremeum, postea lutescens; margine indeterminato.
Systema hyphale monomiticum; hyphae basales hyalinae, tenuitunicatae vel plerumque crassitunicatae, plus minus rectae, leves, 5-6 µm latae; hyphae subhymeniales tenuitunicatae, circiter 4 µm latae; hyphae omnes fibulatae.
Cystidia nulla. Basidia subclavata vel plerumque tubularia, tenuitunicata, constricta et sinuosa, 30-35(-40) x 5-7 µm, 4 sterigmatibus. Sporae subglobosae, crassitunicatae, asperae,
(6-)7-8(-9.5) x (5.5-)6.-6.5(-7) µm, amyloideae, cyanophilae.
Holotypus: Chile, Osorno, P.N. Puyehue, Antillanca, 1500 m., on dead branch in Nothofagus and Drimys winteri forest, 15 April 1988, Rajchenberg No. 4185 (BAFC). Isotypi: GB and O.

BASIDIOME resupinate, effuse, loosely adnate, rather thin and pellicular.
HYMENOPHORE smooth, at first white to cream-coloured, then pale yellowish, margin indeterminate or usually paler than the fertile part.
HYPHAL SYSTEM monomitic; basal hyphae thin-walled to more commonly with a slight wall thickening or even thick-walled next to the substratum, hyaline, rather straight and long-celled, smooth, often branching at right angles, approximately 5-6 µm wide, subhymenial hyphae comparatively short-celled, thin-walled, about 4 µm wide, all hyphae with clamp-connections.

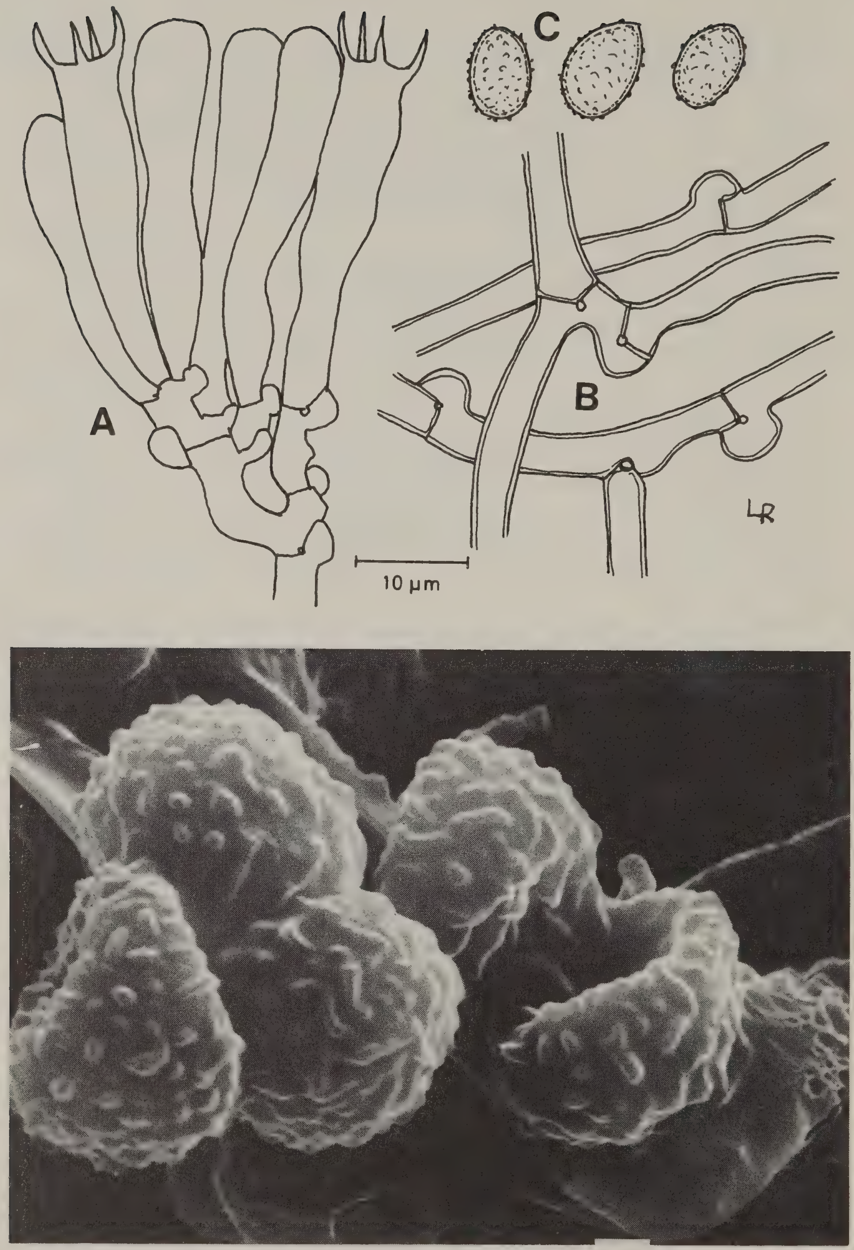

Fig. 1. Amyloathelia aspera A) part of the hymenium, B) hyphae from the subiculum, C) spores, D) SEM of the spores, bar = 1 um. From the holotype.

CYSTIDIA absent.
BASIDIA subclavate or when fully developed almost tubular, thin-walled throughout, constricted and sinuous, 30-35(-40) x 5-7 µm
with four rather long (6-8 µm) sterigmata and a basal clamp-connection.
SPORES subglobose, thick-walled, often with oil drops in the protoplasm, appearing completely smooth in Cotton blue, but slightly rugose in KOH as well as in Melzer's reagent, (6-)7-8(-9.5) x (5.5-)6-6.5(-7) µm, distinctly amyloid and cyanophilous.

The species is easily recognized by its thick-walled, asperulate spores. Its closest relative seems to be Amyloathelia amylacea (Bourd.& Galz.) Hjortst. which, however, has smooth, slightly longer spores and with a stronger amyloidity. The basidia of the latter are in general also shorter.
It should be noted that Corticium vallum G.H. Cunn. was stated to be the same as A. amylacea by Staplers (1985). This must be a misinterpretation of A. amylacea since Stalpers described Cunningham's species with gloeocystidia. A. amylacea (Corticium amylaceum) has no cystidia, only occasional hyphal ends between the basidia. Original material of Corticium vallum has not been studied in this case.

Aleurodiscus exasperatus Hjortst. & Ryv. nov.sp. Fig.2.
Basidioma resupinatum, arcte adnatum, tenue, quasi 0.1-0.2 mm crassum, plus minus coriaceum. Hymenophorum leve vel leviter rugosum, primum cremeum tum griseum vel dilute brunneolum. Systema hyphale monomiticum; hyphae distinctae, tenuitunicatae, modice ramosae, (2.5-)3-3.5 µm latae, sine fibulis. Gloeocystidia generaliter 50-80 x 8-10(-12) µm, tenuitunicata, sulphopositivan contentia. Dendrohyphidiae numerosae, inclusae vel plerumque projectae, ramosissimae, leviter incrustatae. Basidia clavata, grandia, generaliter 70-100 x 12-15 µm, 4 sterigmatibus. Sporae ellipsoideae vel aliquantum fusiformes, tenuitunicatae vel leviter crassiusculae, (15-)20-23 x 8-10 µm, exasperatae, amyloideae.
Holotypus: Brazil, Sao Paulo, Santos, Cananeia, Ilha do Cardoso, 2-5 Feb. 1987, Hjortstam 16760. (K).
Other specimen examined: Argentine: Tucuman, Ruta 38, km 19, no date indicated, leg. H. Gomez. Herb. BAFC 24547.

BASIDIOME resupinate, closely attached to the substratum and hardly detachable, thin to moderately thick, approximately 0.1-0.2 mm thick, more or less coriaceous, confluent.
HYMENOPHORE smooth or slightly pulverulent, cream-coloured or with a greyish tint, with age pale brown. Margin indeterminate.
HYPHAL SYSTEM monomitic; hyphae thin-walled, moderately branched, (2.5-)3-3.5 µm wide, forming a rather dense subiculum, all hyphae without clamp-connections.
GLOEOCYSTIDIA generally numerous, with granular content, 50-80 x 8-10(-12) µ^{m}, blackish in sulphovanillin, thin-walled, with an obtuse tip, basally often with several protuberances.
DENDROHYPHIDIA numerous, projecting slightly above the basidia, richly branched, encrusted.
BASIDIA clavate, large, 70-100 µm long or sometimes longer, with a width of 12-15 µm just below the four stout sterigmata, without a basal clamp-connection.

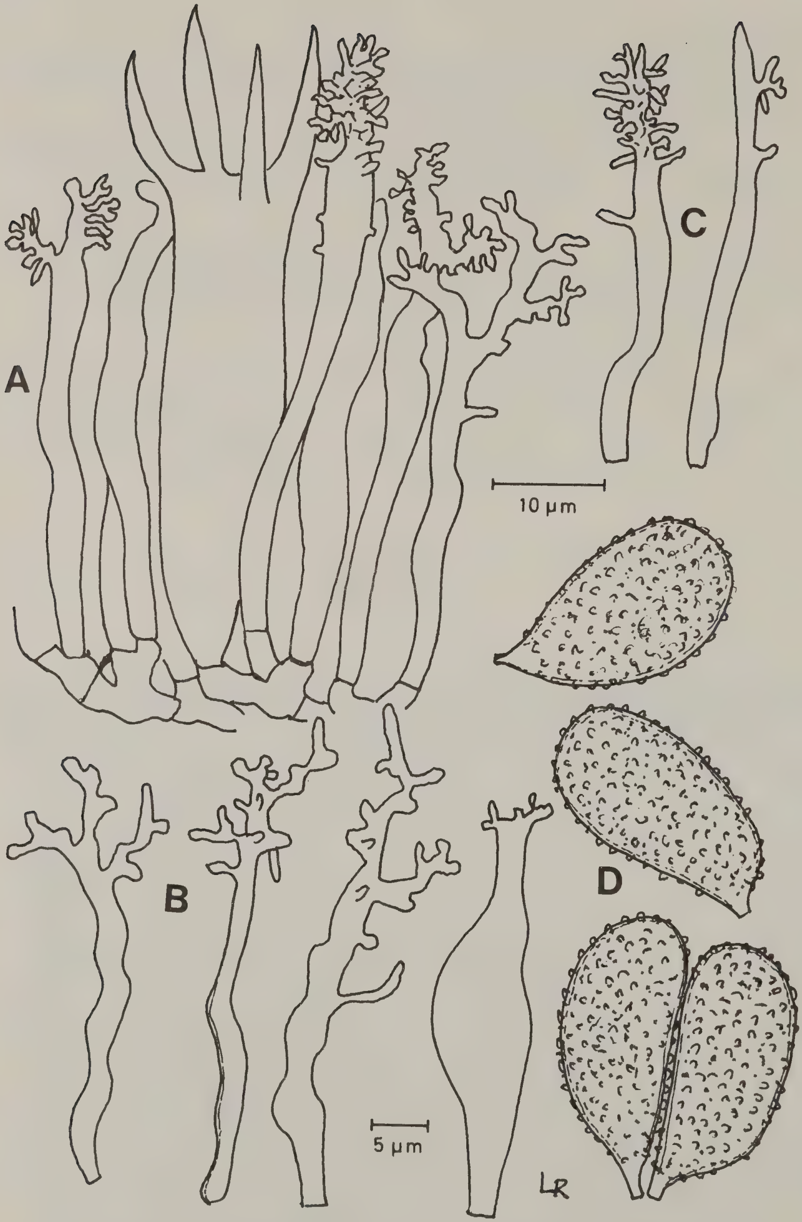
A
C
10 µm
B
D
5 µm
LR

Fig. 2. Aleurodiscus exasperatus A) part of the hymenium, B) dendrohyphidia, C) acanthophyses, D) spores. From the holotype.

SPORES ellipsoid to somewhat fusoid, thin-walled or with slight wall thickening, (15-)20-23 x 9-12 µm, appearing smooth in KOH but slightly rugose in Melzer's reagent, amyloid.

Aleurodiscus exasperatus is similar to A. aurantius (Fr.) Schroet., but differs primarily by its spore shape and gloeocystidia. In the latter species the spores are ellipsoid, never fusoid and distinctly echinulate to verrucose. Further more, the gloeocystidia are moniliform at the apex. Macroscopically, the new species is reminiscent of species of Vuilleminia Maire, but easily separated from species of this genus by the amyloid spores and sulfo-positive gloeocystidia.

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References.

Stalpers, J.A. 1985. Type studies of the species of Corticium described by G.H. Cunningham. N.Z.Journ.Bot. 23:301-310.

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DEMATIACEOUS HYPHOMYCETES ON FREYCINETIA (PANDANACEAE). 4. CRYPTOPHIALE

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Abstract

Two new species of *Cryptophiale* are described and figured, *C. caudata* from Malaysia and *C. novae-caledoniae* from New Caledonia. These fungi were found during a study of dematiaceous hyphomycetes on dead leaves of *Freycinetia.*

Introduction

During an examination of over 70 samples of dead *Freycinetia* leaves from nine countries (McKenzie 1991), only two collections of *Cryptophiale* were found. Both of these, one from New Caledonia and the other from Malaysia, are distinct new species and are described and figured in this paper.

Cryptophiale caudata McKenzie et Kuthubutheen sp. nov. Fig. 1

Coloniae conspicuae, effusae. Conidiophora e cellulis atro-fuscis, macronematosa, mononematosa, singula, eramosa, erecta, apicem versus parum curvata, laevia, septata, brunnea, apice acuta, usque ad 230 μm longa, ad basim 7-10 μm lata, ad apicem 5-7.5 μm. Zona fertilis subapicalis, scutelliformis, 45-60 μm longa, 15-24 μm crassa; cellulae conidiogenosae scutello cellarum sterilium pallide fusco celatae; cellulae steriles 2.5-5 μm latae, extendentes 6-9 μm ultra conidiophororum parietem. Conidia hyalina, adherentia, clavata vel fusiformia, subulata, laevia, guttulata, eseptata, (20-) 23-26 (-28) x 4-4.25 μm, apicem versus 10-25 μm longa, basi obconice truncata.

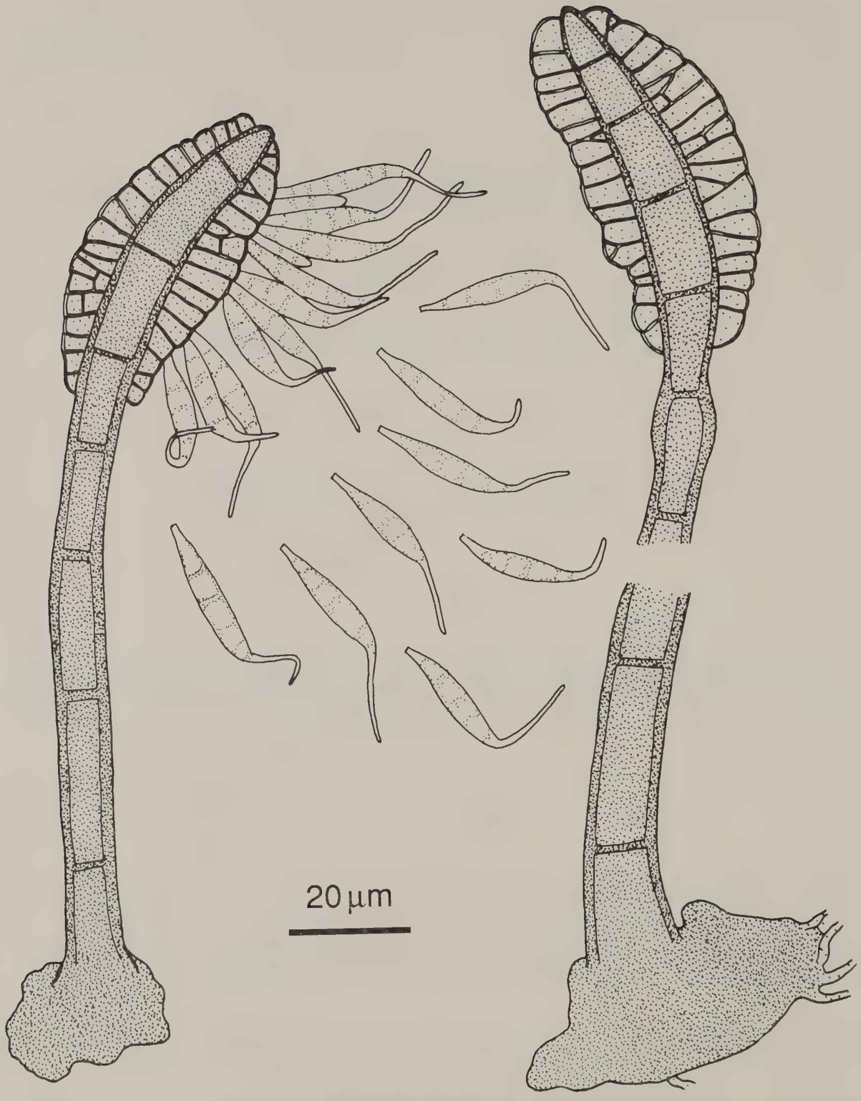

Figure 1 *Cryptophiale caudata*, conidiophores and conidia (PDD 60584 - type). Specimen mounted in hydrous lactophenol.

In foliis mortuis pandanaceae *Freycinetia* sp.
Holotypus PDD 60584.

Colonies conspicuous, effuse. Conidiophores arising from dark brown, smooth, swollen cells, macronematous, mononematous, single, unbranched, erect, slightly curved towards the apex, smooth, septate, brown, abruptly tapered to an acute apex, up to 230 μm long x 7-10 μm thick near the base, tapering to 5-7.5 μm near the apex. Fertile region subapical, 45-60 μm long, 15-24 μm wide. Conidiogenous cells obscured by a shield of sterile, pale brown cells; each shield cell 2.5-5 μm wide, extending 6-9 μm beyond the conidiophore wall. Conidia produced in slime and adhering to the fertile part of the conidiophore in a lateral droplet; hyaline, clavate or fusiform, subulate, smooth, guttulate, not appearing septate, (20-) 23-26 (-28) x 4-4.25 μm, tapering to form a single, 10-25 μm long flexuous appendage at the distal end, base long, obconically truncate.

On *Freycinetia* sp.
Specimen examined: **Malaysia**, Selangor, Genting Highlands, Gunung Bunga Buah, 18.VIII.1992, E.H.C. McKenzie (PDD 60584 - **holotype**).

The specific epithet refers to the tail-like appendage on the conidia.

Cryptophiale novae-caledoniae McKenzie et Kuthubutheen sp. nov. Fig. 2

Coloniae conspicuae, effusae. Conidiophora e cellulis atro-fuscis, macronematosa, mononematosa, singula, eramosa, erecta, recta vel flexuosa, laevia, septata, obscure rubro-brunnea, apicem versus parce pallidiora, acuta, usque ad 450 μm longa, ad basim 10-11 μm lata, ad apicem 4-6.5 μm. Zona fertilis apicalis, scutelliformis, 35-80 μm longa, 13-14 μm crassa; cellulae conidiogenosae scutello cellarum sterilium pallide fusco celatae; cellulae steriles 2.5-3.5 μm latae, extendentes 3-4 μm ultra conidiophororum parietem. Conidia hyalina, adherentia, fusiformia, laevia, medio septata, (9.5-) 14-16 (-18) x 2-2.25 μm, apice rotundata vel acuta, basi rotundata vel obconice truncata.

In foliis mortuis pandanaceae *Freycinetia* sp.
Holotypus PDD 60585.

Colonies conspicuous, effuse. Conidiophores arising from dark brown, smooth, swollen cells, macronematous, mononematous, single, unbranched, erect, straight or flexuous, smooth, septate, dark reddish-brown, slightly paler towards an acute apex, up to 450 μm long x 10-11 μm thick near the base, tapering to 4-6.5 μm in the fertile region. Fertile region apical, 35-80 μm long, 13-14 μm wide. Conidiogenous cells obscured by a shield of sterile, pale brown cells; each shield cell 2.5-3.5 μm wide, extending 3-4 μm beyond the conidiophore wall. Conidia produced in slime and adhering to

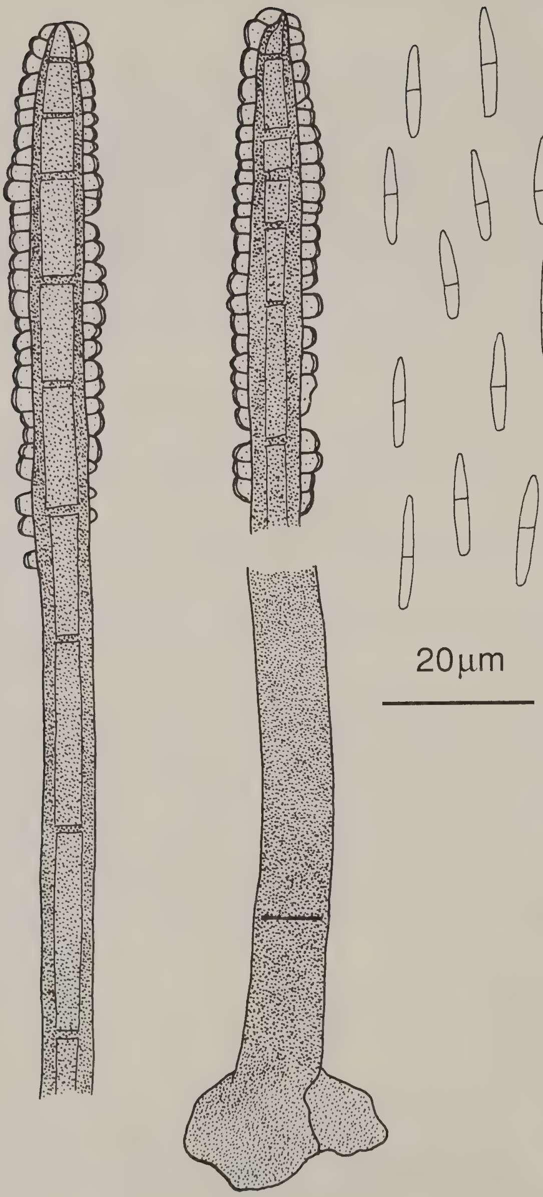

Figure 2 *Cryptophiale novae-caledoniae*, conidiophores and conidia (PDD 60585 - type). Specimen mounted in hydrous lactophenol.

the fertile part of the conidiophore in a lateral droplet; hyaline, fusiform, smooth, medianly 1-septate, (9.5-) 14-16 (-18) x 2-2.25 μm, apex rounded or acute, base rounded or obconically truncate.

On *Freycinetia* sp.
Specimen examined: **New Caledonia**, Mt Panié, 1500m, 15.XII.1990, J.S. Dugdale (PDD 60585 - **holotype**).

The specific epithet refers to the country where the species was found.

Sutton et al. (1989) provided a key to nine species of *Cryptophiale* then known; a tenth species, *C. secunda* Kuthubutheen & Sutton having been previously transferred to *Cryptophialoidea* Kuthubutheen & Nawawi (1987). McKenzie (1993) has recently described a new species, *C. insularis*, from New Zealand. *C. caudata* and *C. novae-caledoniae* can be distinguished from other species in the genus by the structure of the conidiophore apex, size of conidia, and position of the fertile region on the conidiophore.

C. caudata is similar in several respects to *C. aristata* Kuthubutheen & Sutton (1985) and to *C. enormis* Sutton, Nawawi & Kuthubutheen (1989). The apex of the simple, setiform conidiophore in all three species extends not more than 10 μm beyond the fertile region. The conidiophore of *C. enormis*, however, is wider at the fertile region than above or below it. The conidia in all three species are caudate. The conidia of *C. aristata* are 23-27 x 2-3 μm and 1-septate and the apical cell is drawn into a filiform appendage 7-12 μm long. Although the conidial length of *C. caudata* and *C. aristata* is similar, in *C. caudata* the conidia are broader, 0-septate, and the apical flexuous appendage is 10-25 μm long. The conidia of *C. enormis*, however, are twice as large as those of *C. caudata*, 4-7 septate, and have shorter (5-8 μm) appendages.

C. novae-caledoniae is reminiscent of *C. kakombensis* Pirozynski (1968), a species widely distributed in the tropics and subtropics. The conidia of *C. kakombensis*, however, are falcate, longer but narrower (22-28 x 1-2 μm), and acute at both ends compared to the conidia of *C. novae-caledoniae*. The fertile region of *C. kakombensis* is subapical and not apical as in *C. novae-caledoniae*. The apical location of the fertile region in *C. novae-caledoniae* is unique and not found in any of the known species in the genus.

Acknowledgment

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References

Kuthubutheen, A.J.; Nawawi, A. 1987: *Cryptophialoidea* gen. nov. on decaying leaves from Malaysia. *Transactions of the British Mycological Society 89*: 581-583.

Kuthubutheen, A.J.; Sutton, B.C. 1985: *Cryptophiale* from Malaysia. *Transactions of the British Mycological Society 84*: 303-306.

McKenzie, E.H.C. 1991: Dematiaceous hyphomycetes on *Freycinetia* (Pandanaceae). 1. *Stachybotrys. Mycotaxon 41*: 179-188.

McKenzie, E.H.C. 1993: New hyphomycete species from litter in the Chatham Islands, New Zealand. *Mycotaxon 46*: 291-297.

Pirozynski, K.A. 1968: *Cryptophiale*, a new genus of hyphomycetes. *Canadian Journal of Botany 46*: 1123-1127.

Sutton, B.C.; Nawawi, A.; Kuthubutheen, A.J. 1989: Additions to *Belemnospora* and *Cryptophiale* from Malaysia. *Mycological Research 92*: 354-358.

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GENETICS OF A *TUBER AESTIVUM* POPULATION (Ascomycotina, Tuberales)

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Key-words: Tuberales, *Tuber aestivum*, *Tuber uncinatum*, truffle, allozymes, reproduction, sibling species.

Abstract: A truffle population with of *Tuber aestivum* and *Tuber uncinatum* morphotypes was subjected to allozyme analysis via SGE and genotypically scored at fourteen loci. Ten of the loci were monomorphic and four polymorphic. Thus, seventeen new genotypic classes, with very low genetic differentiation, were found. However, heterozygosity was never found and all alleles seem to be fixed in individuals. These results indicate that *Tuber aestivum* and *T. uncinatum* are probably two extreme morphological forms of a complex of self-fertilizing sibling species.

Introduction

Some taxonomic complexes of the genus *Tuber* Mich. ex Fr. are very difficult to distinguish on a morphological basis. For *Tuber aestivum* Vitt., a European taxon, also found in Algeria and Turkey, there seems to be a long list of probable synonyms. Beyond the nomenclatural problems, the difficulty in distinguishing species has produced confusion in regulating and marketing these species worldwide. CHEVALIER *et al.* (1978) in an attempt at separating *Tuber uncinatum* Chat. as a distinct species, tried without much success to juxtapose its morphological characters with those of *T. aestivum*. GROSS (1987) proposed to divide these two taxa on the basis of the height of the sporal reticulum. Moreover, in two previous reports, no heterozygosity was found for several loci in a number of *Tuber* species (PACIONI & POMPONI, 1989; 1991). An investigation at the population

level, to test the hypothesis that a selfing process of reproduction may be responsible for the homozygosity, therefore appears of some interest.
This paper reports the results of using allozyme analysis to resolve the status of *Tuber aestivum* and *T. uncinatum*.

Materials and Methods

A sample of 66 specimens, morphologically related to *Tuber aestivum* and *Tuber uncinatum*, was collected during 1990 and 1991 in the 'Le Pozze', a small truffle preserve, near the village of Santi, in L'Aquila (The Abruzzi, Italy). The specimens, determined by the senior author, have been preserved, one portion cut in little sticks and then deep-frozen and a small portion dried and deposited in the mycological herbarium of L'Aquila (AQUI) as a voucher.
Horizontal starch gel (SGE) was performed essentially according to PACIONI & POMPONI (1989) and FRIZZI & TAMMARO (1991). Some slight modifications were made in the staining solutions. The stains were basically prepared according to HARRIS (1966), except for the SKDH stain (FINESCHI, 1983).
Electrophoresis was conducted at a constant 8V/cm for approximately 3.5 hours per run.
Details on the electrophoretic techniques used are given in Table 1.

A preliminary survey showed fourteen enzymatic loci produced patterns clearly interpretable from a genetic point of view: *Pgm-2* (PGM, phosphoglucomutase), *G6pd* (G6PD, glucose-6-phosphate dehydrogenase), *6-Pgd* (6PGD, phosphogluconate dehydrogenase), *Hk* (HK, hexokinase), *Mpi-1* (MPI, mannose phosphate isomerase), *Ak* (AK, adenylate kinase), *Pgi* (PGI, glucose phosphate isomerase), *Mdh-2* (MDH, malate dehydrogenase), *Me-1* and *Me-3* (ME, malic enzyme), *Idh* (IDH, isocitrate dehydrogenase), *Sod-1* (SOD, superoxide dismutase), *Skdh* (SKDH, shikimic dehydrogenase).
With a view to comparing the resulting elecrophoretic data to all known data for *Tuber*, the previous reference for the mobility of the enzymes of *Tuber melanosporum* Vitt. (=100) was mantained.
Electrophoretic data were analysed using the NTSYS-pc program (ROHLF,1987) and genetic divergence was estimated with the index of standard distance (D) proposed by NEI (1972).

Results

Nine of the fourteen enzymatic loci examined (*G6pd*, *6Pgd*, *Adk*, *Got*, *Pgi*, *Me-3*, *Skdh*, *Mdh-1*, *Sod*) are monomorphic showing the same phenotype as one band. The *Pgm-2* locus is also monomorphic, however it is distinguished by three bands. The *Pgm-2* pattern has been reported for all other taxa of *Tuber* already examined (PACIONI & POMPONI, 1989; 1991). The cause of the *Pgm-2* pattern is still unexplained. The relative mobility of the above enzyme electrophoretic patterns are: *6Pgd* 103, *Adk* 100, *Got* 105, *Pgi* 100, *Me-3* 110, *Skdh* 100, *Mdh-1* 100, *Sod* 93, *Pgm-2* 85. Only four loci (*Hk*, *Mpi-1*, *Me-1*, *IdH*) appeared polymorphic. At locus *Hk* three alleles (108, 110, 112) were found, two (95, 100) at *Mpi-1*, two (105, 110) at *Me-1* and three (90, 95, 100) at *Idh*.

Heterozygosity was not found and all alleles seem to be fixed individuals.

The electrophoretic patterns revealed seventeen genotypic classes (ROYSE & MAY, 1982). Only the four polymorphic loci are reported (Table 2). Their genetic distances are very low (D= 0,074 to 0,336) within the values of an intraspecific variability, confirming the overlapping of the morphocharacters. Figure 1 shows one of the possible clustering trees. The enzyme phenotype, belonging to the genotypic class labeled TA2, seemed to be the most common. Several phenotypes were only observed once. The number of phenotypes found is almost equal to that of the truffle habitats sampled.

For loci in common, the genotypic classes found here are completely different from those previously observed in samples from other Italian localities (PACIONI & POMPONI, 1991).

Discussion

The homozygosity of truffles has been reported previously in the studies on the *Tuber aestivum-T. mesentericum* group (PACIONI & POMPONI, 1991) as well as on several other taxa of *Tuber* (PACIONI & POMPONI, 1989). However vegetative cells of the truffle sporophores contain a pair of nuclei (FASOLO-BONFANTE & BRUNEL,1972) and therefore a certain percentage of heterozygosity should be present, unless the two nuclei arise from self-fertilization or mitosis.

Our results strongly support the hypothesis that in dikaryotic hyphae, the two nuclei result from selfing; accordingly non-heterozygosity is observed. This is at variance with what is known about truffle reproduction, hitherto supposed to be heterothallic (DANGEARD 1895/96; GRENTE *et al.*, 1972).

Sexual reproduction by selfing would restrict, in this group of fungi, variability to inter- and intrachromosomal recombination and mutation. As stated in the Results, only four of fourteen loci examined appeared polymorphic and this may favour the hypothesis that a strong selection, due to the peculiar ecology and life cycle of truffles, has been operating on the ten monomorphic loci, whereas it has been less stringent on the polymorphic loci. It should be noted, however, that, in truffles, very little information is available about the structures, functions and molecular properties of the enzymes investigated here. In fact, the polymorphism observed might be ascribed to alleles of the same locus, to alleles of entirely different loci differentially expressed in the various samples, or to conformational variants (DAWSON, 1972) of the same locus expressed in different sporophores.

In the light of the present results, we think that the sporophores of *Tuber aestivum* or *T. uncinatum* represent only two extreme forms, at present unresolvable by morphological and biometrical methods.

The existence of a great number of sibling species suggests that our knowledge of *Tuber* reproduction is still very scanty and requires more investigation.

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References

BREWER,G. & SING,C.F., 1970. An introduction to isozyme techniques. London & New York: Academic Press.

CHEVALIER, G., DESMAS, C., FROCHOT, H. & RIOUSSET, L., 1978. L'éspece *Tuber aestivum* Vitt. : I. Definition. *Mushroom Science* **10**: 957-975.

DANGEARD, P.A., 1895/96. La Truffle. Recherches sur son développement, sa structure, sa reproduction sexuelle. *Botaniste* **4/5**:63-87.

FASOLO-BONFANTE,P. & BRUNEL,A., 1972. Caryological features in a mycorrhizal fungus: *Tuber melanosporum*. *Allionia* **18**: 5-11.

FINESCHI, S., 1983: Variabilità intraspecifica in *Pinus nigra* Arn.. Risultati di analisi su alcuni sistemi isoenzimatici. *L'Italia Forestale e Montana* **38**: 200-213.

FRIZZI, G. & TAMMARO, F., 1991. Electrophoretic study and genetic affinity in the *Campanula elatines* and *C. fragilis* (Campanulaceae) rock-plants group from Italy and W. Jugoslavia. *Plant Syst. Evol.* **174**: 67-73.

GRENTE, J., CHEVALIER, G. & POLLACSEK, A., 1972. La germination de l'ascospore de *Tuber melanosporum* et de la synthése sporale des mycorrhizes. *C.R. Acad. Sc. Paris* **275**D: 743.

GROSS, G., 1987. Zur den europaischen Sippen der Gattung *Tuber*. In DERBSCH, H., & SCHMITT, J.A., (Eds.): *Atlas der Pilze des Saarlandes, 2: Nacweise, Okologie, Vorkommen und Beschreibungen*, pp.79-99. Saarbrucken, Germany: Ed. Delattinia.

HARRIS, H., 1966. Enzyme polymorphism in man. *Proc. Roy. Soc. London* B *169*: 298-310.

NEI, M., 1972. Genetic distance between populations. *Americ. Nat. 106*: 238-292.

PACIONI, G. & POMPONI, G., 1989. Chemotaxonomy of some Italian species of *Tuber*. *Micol. Veget. Medit.* **4**: 63-72.

PACIONI, G. & POMPONI, G., 1991. Genotypic patterns of some Italian populations of the *Tuber aestivum-T. mesentericum* complex. *Mycotaxon* **42**: 171-179.

ROHLF, F.J., 1987. NTSYS-pc Numerical Taxonomy and Multivariate Analysis System. Setauker, N.Y., U.S.A.: Exeter Publishing.

ROTHE, G., 1973. Shikimisaure-Dehydrogenase in keimenden Erbsen. *Biochem. Biophys. Pflanzen* **164**: 475-486.

ROYSE, D.J. & MAY, B., 1982. Use of isozyme variation to identify genotypic classes of *Agaricus brunnescens*. *Mycologia* **74**: 93-102.

SELANDER, R.K., SMITH , M.H., YANG S.Y., JONHSON, W.E. & GENTRY, J.B., 1971. Biochemical polymorphism in the genus *Peromyscus*. I. Variation in the old field mouse (*Peromyscus polionotus*). *Stud. Genet.* **6**: 49-90.

SHAW, C.R. & PRASAD, R., 1970. Starch gel electrophoresis of enzymes. A compilation of recipes. *Biochem. Genet.* **4**: 297-320.

Table 1. SGE conditions for detection of isozymes and allozymes in *Tuber aestivum* Vitt.

enzymes	E.C. number	buffer	pH	references
MDH	1.1.1.37	2	7.2	BREWER & SING (1970)
ME	1.1.1.40	1	8.2	HARRIS (1966)
IDH	1.1.1.42	1	8.2	BREWER & SING (1970)
6PGD	1.1.1.44	4	8.0	SHAW & PRASAD (1970)
G6PD	1.1.1.49	1	8.2	BREWER & SING (1970)
SOD	1.15.1.1	1	8.2	HARRIS (1966)
GOT	2.6.1.1	3	8.0	SELANDER & al.(1971)
HK	2.7.1.1	4	8.0	SHAW & PRASAD (1970)
AK	2.7.4.3	2	7.2	BREWER & SING (1970)
PGM	2.7.5.1	2	7.2	BREWER & SING (1970)
MPI	5.3.1.8	4	8.0	HARRIS (1966)
PGI	5.3.1.9	1	8.2	BREWER & SING (1970)
SKDH	1.1.1.25	3	8.0	ROTHE (1973)

Buffer systems used: **1**- Lithium/borate (SHAW & PRASAD, 1970); **2**-Tris/maleate (BREWER & SING, 1970); **3**- Tris/citrate continous II (SELANDER *et al.*, 1971); **4**-Tris/versene/borate (SHAW & PRASAD, 1970)

Table 2. Polymorphic loci of the genotypic classes (**TA**) observed in a natural population of *Tuber aestivum* Vitt.(the number of specimens shown in brackets)

	Idh	*Hk*	*Mpi-1*	*Me-1*
TA1(4)	95/95	108/108	100/100	110/110
TA2(23)	95/95	110/110	100/100	110/110
TA3(2)	95/95	112/112	100/100	110/110
TA4(1)	95/95	110/110	100/100	105/105
TA5(8)	100/100	110/110	100/100	110/110
TA6(1)	100/100	112/112	100/100	110/110
TA7(1)	90/90	108/108	100/100	110/110
TA8(3)	90/90	112/112	100/100	110/110
TA9(2)	90/90	110/110	100/100	110/110
TA10(7)	95/95	110/110	95/95	110/110
TA11(5)	95/95	108/108	95/95	110/110
TA12(1)	100/100	110/110	95/95	110/110
TA13(1)	100/100	108/108	95/95	110/110
TA14(2)	90/90	110/110	95/95	110/110
TA15(1)	90/90	110/110	95/95	105/105
TA16(1)	100/100	110/110	100/100	105/105
TA17(3)	100/100	110/110	95/95	105/105

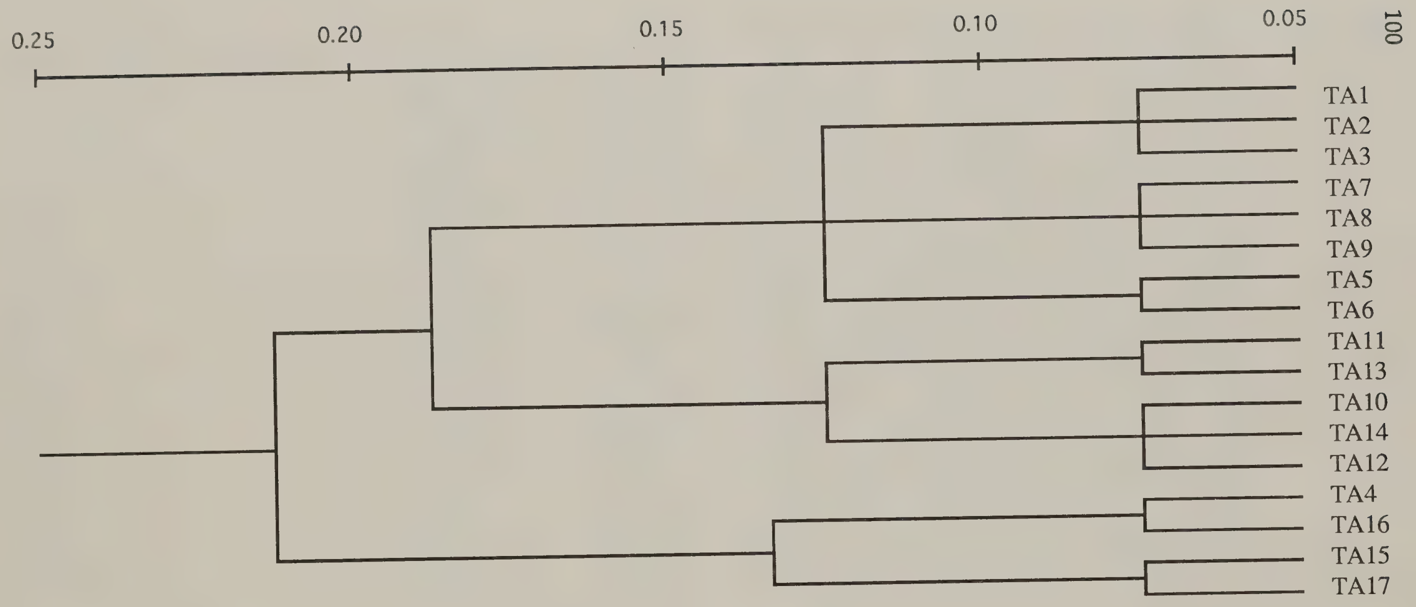

Fig.1 - Dendrogram of the Nei's genetic distances for the seventeen genetic classes of *Tuber aestivum* Vitt.

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NEW SPECIES IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM AUSTRALIA

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ABSTRACT : The species, *Bulbothrix microscopica* Elix, *Canoparmelia herveyensis* Elix, *Canoparmelia subarida* Elix, *Canoparmelia whinrayi* Elix, *Flavoparmelia kantvilasii* Elix, *Hypotrachyna booralensis* Elix, *Hypotrachyna proserpinensis* Elix, *Hypotrachyna subpustulifera* Elix, *Neofuscelia kondininensis* Elix, *Neofuscelia imitatricoides* Elix, *Neofuscelia parasitica* Elix, *Neofuscelia scabrosina* Elix, *Neofuscelia subbarbatica* Elix, *Paraparmelia yamblaensis* Elix, *Parmelia crowii* Elix, *Parmelina euplectina* Elix, *Parmelina johnstoniae* Elix, *Parmelinopsis protocetrarica* Elix, *Parmotrema submerrillii* Elix, *Xanthoparmelia austroconstrictans* Elix, *Xanthoparmelia canobolasensis* Elix, *Xanthoparmelia hyposalazinica* Elix, *Xanthoparmelia masonii* Elix and *Xanthoparmelia trirosea* Elix are described as new. A new name is given to *Xanthoparmelia xanthofarinosa* Elix (formerly *X. xanthosorediata*). The following new combinations are made: *Bulbothrix queenslandica* (Elix & Stevens) Elix, *Bulbothrix subtabacina* (Elix) Elix, *Canoparmelia owariensis* (Asah.) Elix, *Canoparmelia pustulescens* (Kurok.) Elix, *Canomaculina melanochaeta* (Kurok.) Elix, *Imshaugia evernica* (Elix & Johnst.) Elix, *Parmotrema pseudovirens* (Gyelnik) Elix and *Rimeliella haitiensis* (Hale) Elix.

Introduction

As a result of further study of the lichen family Parmeliaceae in Australia (Elix & Johnston 1986, 1987a, 1987b, 1987c, 1988a, 1988b, 1988c; Elix, Johnston & Armstrong 1986; Nash & Elix 1987), I am describing 24 new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson, Culberson & Johnson 1981; Culberson & Johnson 1982; Elix, Johnston &

Parker 1987, 1988), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

Bulbothrix microscopica Elix sp. nov. Fig. 1

Species cum thallo ut in *Bulbothrix subtabacina* sed ab hac specie thallo diminuto, lobis angustioribus, emaculatis et ciliis inflatis differt.

Type: Australia. Queensland. On mangroves along the foreshore of Tin Can Inlet, Tin Can Bay, 25°54'S, 153°01'E, 1 m, *J. A. Elix 22862*, 3.vii.1989; holo: CBG.

Thallus corticolous, adnate to tightly adnate, mineral grey, 1-2 cm diam. *Lobes* sublinear, 0.1-0.5 mm wide, subdichotomously branched, margins densely bulbate-ciliate, bulbate *cilia* shiny, markedly inflated. *Upper surface* plane, emaculate, moderately to densely isidiate, the isidia simple, less than 0.15 mm high. Medulla white. *Lower surface* black shiny, moderately to densely rhizinate to the margins, rhizines black, simple or tufted at apices. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow, medulla K+ yellow-red, C-, P+ orange; containing atranorin, chloroatranorin, salazinic acid (major), consalazinic acid (minor).

The minute thallus, very narrow lobes, simple isidia, black lower surface and medullary salazinic acid distinguish this species. *P. subtabacina* Elix a related species *(vide infra)*, has broader (0.5-1.0 mm wide), sublinear-elongate lobes with a distinctly maculate upper surface, slender, elongated bulbate cilia which are commonly branched subapically and dichotomously branched rhizines. Currently this rare endemic species is only known from the type locality.

Canoparmelia herveyensis Elix sp. nov. Fig. 2

Species cum thallo ut in *Canoparmelia raunkiaeri* sed ab hac specie medulla inferiore pigmento ochraceo et euplectino continente differt.

Type: Australia. Queensland. On granite rocks in dry sclerophyll forest, Hervey Range, 45 km south-west of Townsville, 19°26'S, 146°24'E, 350 m, *J. A. Elix 20427 & H. Streimann*, 20.vi.1986; holo: CBG; iso: MEL.

Thallus adnate, saxicolous, pale mineral grey, 5-8 cm diam. *Lobes* subirregular, apically rotund, 2-4 mm wide. *Upper surface* plane, becoming irregularly rugose towards the centre, pustulate-sorediate, the pustules coalescing in a coarsely sorediate mass in the older portions of the thallus. *Medulla* white for the most part but pigmented yellow-orange to orange-brown adjacent to lower surface. *Lower surface* black, sparsely rhizinate, rhizines simple, with a narrow bare, brown zone at the margins. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K+ yellow, medulla K-, C-, KC-, P+ orange-red, lower medulla K+ violet; containing atranorin, chloroatranorin, protocetraric acid (major), virensic acid (trace), euplectin (minor).

This new species resembles *Canoparmelia raunkiaeri* (Vainio) Elix & Hale as both develop pustulate soredia towards the centre of the thallus and contain medullary protocetraric acid. However, *C. herveyensis,* is clearly distinguished by the partially orange-yellow pigmented lower medulla due to the presence of the anthraquinone, euplectin. At present this new species is only known from the type locality where it appears quite common.

Canoparmelia subarida Elix sp. nov. Fig. 3

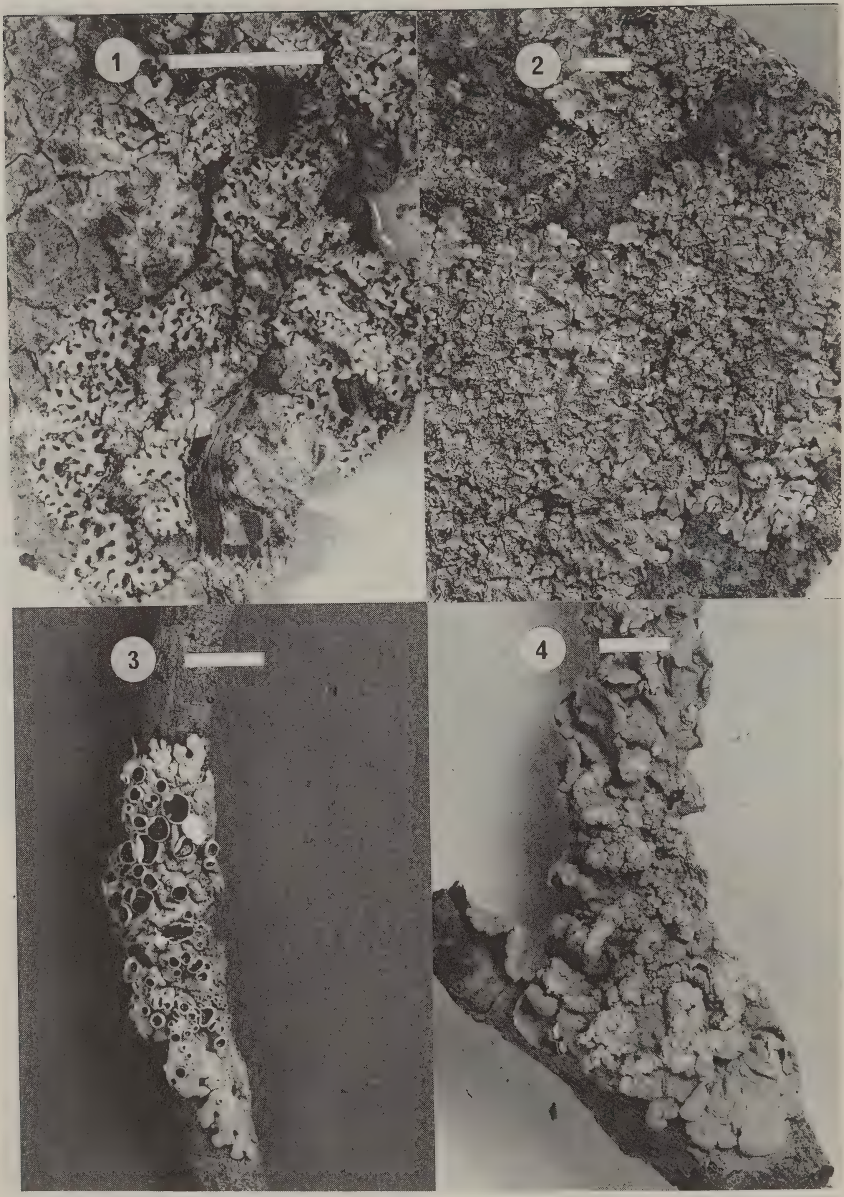
Species cum thallo ut in *Canoparmelia macrospora* sed ab hac specie sporis brevioribus et acido lecanorico continente differt.

Type: Australia. Western Australia. On twigs, South Stirling sand plain, 4 km off the Chillinup road, *N. Sammy UWA8,* 12.viii.1970; holo: PERTH.

Thallus corticolous, adnate, pale mineral grey, 1-3 cm in diam. *Lobes* subirregular, crowded and imbricate, 1.0-2.0 mm wide. *Upper surface* smooth and shiny at the apices, plane or weakly foveolate at first, becoming wrinkled and rugose with age, lacking soredia and isidia. Medulla white. *Lower surface* ivory to pale brown, moderately to densely rhizinate, rhizines concolorous with the lower surface, simple or tufted at the tips. *Pycnidia* numerous, punctiform, black; conidia cylindrical 5-6 x 1 µm. *Apothecia* common, sessile, 0.5-2 mm in diam., disc concave at first but becoming flattened with age, chestnut brown to dark brown, epruinose; margin thin, entire, smooth; spores (8), colourless, ellipsoid, 7-9 x 5-6 µm.

Chemistry. Cortex K+ yellow, medulla K-, C+ red, P- ; containing atranorin, chloroatranorin, lecanoric acid (major), orsellinic acid (trace), unknown (trace).

This species is one of the few species of *Canoparmelia* with a pale lower surface. In gross morphology *C. subarida* closely resembles *C. macrospora* Elix & Johnston, but the latter species is distinguished by the maculate apical lobes which are densely pruinose, the large (16-20 x 5-6 µm) often curved spores and medullary scabrosin 4,4'-diacetate. *C. subarida* is chemically identical to *C. pruinata*, but the latter species is distinguished by the much larger (4-15 mm), pruinose apothecia and a black lower surface. *C. subarida* appears to be a rare species in the subarid inland areas of southern Australia.



Figures 1-4. New species of Parmeliaceae: 1, *Bulbothrix microscopica* (holotype in CBG); 2, *Canoparmelia herveyensis* (holotype in CBG); 3, *Canoparmelia subarida* (holotype in PERTH); 4, *Canoparmelia whinrayi* (holotype in MEL). Scale bar = 5 mm.

Specimens Examined

VICTORIA. On twigs, W side of Wyperfeld National Park, along fire access trail, c. 31.5 km W of Wonga Hut, *R. Filson 16024*, 29.viii.1978 (MEL). SOUTH AUSTRALIA. On bark of *Acacia aneura*, 20 km W of Vokes Corner, 28°34'S, 130°29'E, *N. N. Donner 7376*, 23.viii.1980 (AD).

Canoparmelia whinrayii Elix sp. nov. Fig. 4

Species cum thallo ut in *Parmelina labrosa* sed ab hac specie thallo subto pallido et cilia desunt differt.

Type: Australia. Tasmania. On twigs, north-west of Trig Point, Flinders Island, *John Whinray*, 1.ii.1969; holo: MEL.

Thallus corticolous, adnate, olive-grey to mineral grey, c. 7 cm diam. *Lobes* subirregular and apically subrotund, 3-5 mm wide, lacking cilia. *Upper surface* plane to wrinkled, foveolate, shining or rather waxy, sorediate; soralia laminal or marginal, white, becoming grey-brown with age, originating from coarse pustular ridges, spreading over the thallus. Medulla white. *Lower surface* ivory to pale tan, moderately rhizinate, rhizines simple, concolorous with lower surface. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow, medulla K-, C+ red, P-; containing atranorin, chloroatranorin, lecanoric acid (major).

This unique new species is distinguished by the broad lobes with a pale lower surface, the pustular soralia, the medullary lecanoric acid and the absence of pseudocyphellae and cilia. It is the only sorediate *Canoparmelia* with a pale lower surface so far recorded for Australia. In overall growth form and in the development of soralia, this new species resembles *Parmelina labrosa* (Zahlbr.) Elix & Johnston, but the latter is distinguished by the sparse marginal cilia and the black lower surface. At present this species is only known from the type collection.

Flavoparmelia kantvilasii Elix sp. nov. Fig. 5

Species cum thallo ut in *Flavoparmelia euplecta* sed ab hac specie thallo diminuto, medulla albida, inferiore nonpigmentifera et euplectino noncontinente differt.

Type: Australia. New South Wales. On twigs of *Lomatia arborescens* in *Eucalyptus pauciflora* woodland, Thunderbolt Lookout, Barrington Tops National Park, 25°54'S, 153°01'E, 1450 m, *G. Kantvilas 426/88*, 4.vii.1988; holo: HO, iso: NSW, ANUC.

Thallus corticolous, adnate, green to yellow-green, 2-4 cm in diam. *Lobes* irregularly rotund, incised, margins crenulate, 2.0-5.0 mm wide; secondary lobes narrower, overlying the marginal lobes. *Upper surface* plane, matt, smooth at the marginal lobes becoming slightly rugulose towards the centre of the thallus, isidia absent, *pustulate-servediose;* soralia sometimes developing from cracks or pustules which burst to form granular soredia. Medulla white. *Lower surface* jet black, with a pale brown bare zone at the lobe ends, sparsely rhizinate; rhizines simple or fasciculate. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, medulla K-, C-, P+ red; containing usnic acid, protocetraric acid (major), atranorin (±), caperatic acid, virensic acid (± trace), unknown (± trace).

Morphologically this species closely resembles *Flavoparmelia euplecta* (Stirton) Hale as both species have adnate thalli with a pustulate sorediate upper surface and contain protocetraric acid as a major medullary constituent. However the thalli of *F. kantvilasii* are smaller (2-4 cm cf. 4-12 cm) and more fragmented, not only when growing on its normal twig habitat but even when found on broader branches. Furthermore *F. kantvilasii* lacks the orange pigmented lower medulla (K+ purple, containing euplectin) so characteristic of *F. euplecta*. *F. kantvilasii* is found in the temperate forests of northern New South Wales.

Specimens Examined

NEW SOUTH WALES. On *Ficus* in coastal *Eucalyptus* forest, Telegraph Point, 25 km NNW of Port Macquarie, 31°19'S, 152°48'E, *K. L. Gaul*, viii.1986 (ANUC); on canopy twigs of *Nothofagus moorei* in rainforest, Burraga Swamp, Mt Allyn Forest Park, Chichester State Forest, 32°06'30"S, 151°25'30"E, 1000 m, *G. Kantvilas 187/88*, 29.vi.1988 (ANUC, HO, NSW); on canopy twigs of *Nothofagus moorei* in rainforest, Barrington Tops National Park, Mt William, 1400 m, *G. Kantvilas 307/88*, 30.vi.1988 (HO, NSW); on canopy twigs of *Nothofagus moorei* in rainforest, Gloucester Tops, 1150 m, *G. Kantvilas 414/88A;* 2.vii.1988 (HO, NSW); on twigs of *Nothofagus moorei* in rainforest, Tweed Range, Wiangerie Forest Drive, Antarctic Beech Walk, 1000 m, *G. Kantvilas 703/88*, 3.viii.1988 (HO, NSW); on canopy twigs of *Nothofagus moorei*, New England National Park, Cascade Creek near Wright's Lookout, *G. Kantvilas 705/88*, 6.viii.1988 (HO, NSW).

Hypotrachyna booralensis Elix sp. nov. Fig. 6

Species cum thallo ut in *Hypotrachyna densirhizinata* sed ab hac specie thallo multo parviore et lobi angustiore differt.

Type: Australia. New South Wales. On bark, in a bushland gully, 3 km west of Booral, *Rex Filson 16764*, 1.ii.1969; holo: MEL.

Thallus corticolous, adnate, whitish-grey to mineral grey, c. 2.5 cm diam. *Lobes* sublinear, 0.5-0.8 mm wide, dichotomously branched, separate, the margins subcrenate. *Upper surface* shiny on younger lobes, dull and irregularly cracked on older lobes, plane, emaculate, sorediate; soralia orbicular, mostly subterminal, capitate. Medulla white. *Lower surface* black, densely rhizinate, rhizines black, moderately dichotomously branched. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow, medulla K-, C-, KC+ rose, P-; containing atranorin, chloroatranorin, alectoronic acid (major).

This new species resembles the American-African species *Hypotrachyna densirhizinata* (Kurok.) Hale in that both are sorediate with capitate soralia and contain alectoronic acid. However *H. densirhizinata* is clearly distinguished by the size of the thallus (6-20 cm diam.), the breadth of the lobes (2-6 mm wide) and the presence of additional α-collatolic acid. At present this new species is only known from the type collection.

Hypotrachyna proserpinensis Elix sp. nov. Fig. 7

Species cum thallo ut in *Hypotrachyna heterochroa* sed ab hac specie thallo laxe adnato, medulla albida, inferiore nonpigmentifera et acido gyrophorico continente differt.

Type: Australia. Queensland. On granite rocks on edge of escarpment in *Eucalyptus-Casuarina* dominated woodland, Clarke Range, 46 km south of Proserpine, 20°50'S, 148°32'E, 800 m, *J. A. Elix 20929 & H. Streimann*, 29.vi.1986; holo: CBG; iso: MEL.

Thallus saxicolous, loosely adnate, whitish mineral grey, 5-9 cm diam. *Lobes* sublinear, contiguous, 1-2 mm wide, subdichotomously branched, apices incised, margins entire, axils sinuous. *Upper surface* plane, continuous, soredia and isidia lacking. Medulla white. *Lower surface* black, moderately to densely rhizinate, rhizines black, densely dichotomously branched. *Pycnidia* scattered, conidia bifusiform 5-7 x 1 μm. *Apothecia* common, substipitate, 2-4 mm diam., thalline exciple smooth to undulate; spores (8), colourless, ellipsoid, 8-11 x 5-7 μm.

Chemistry: Cortex K+ yellow; medulla K-, C+ pink, P-; containing atranorin, chloroatranorin, gyrophoric acid (major), 3-methoxy-2,4-di-*O*-methygyrophoric acid (trace), 2,4-di-*O*-methygyrophoric acid (trace), unknown (minor).

Morphologically this new species resembles *Hypotrachyna heterochroa* (Hale & Kurok.) Elix, as both have narrow sublinear lobes which are commonly fertile and lack soredia and isidia. However whereas the thalli of *H. heterochroa* are adnate, have a pigmented lower medulla and contain protocetraric acid and skyrin, *H. proserpinensis* has loosely adnate thalli with a white medulla containing gyrophoric acid. At present this new species is known only from the type collection.

Hypotrachyna subpustulifera Elix sp. nov. Fig. 8

Species cum thallo ut in *Hypotrachyna pustulifera* sed ab hac specie thallo saxicolo, multo parviore et lobis angustioribus differt.

Type: Australia. New South Wales. On exposed sandstone rocks in dry sclerophyll forest, trail to Pigeon House Mountain, 19 km west of Ulladulla, 35°20'S, 150°16'E, 460 m, *J. A. Elix 21305 & H. Streimann*, 2.xii.1986; holo: CBG; iso HO, MEL.

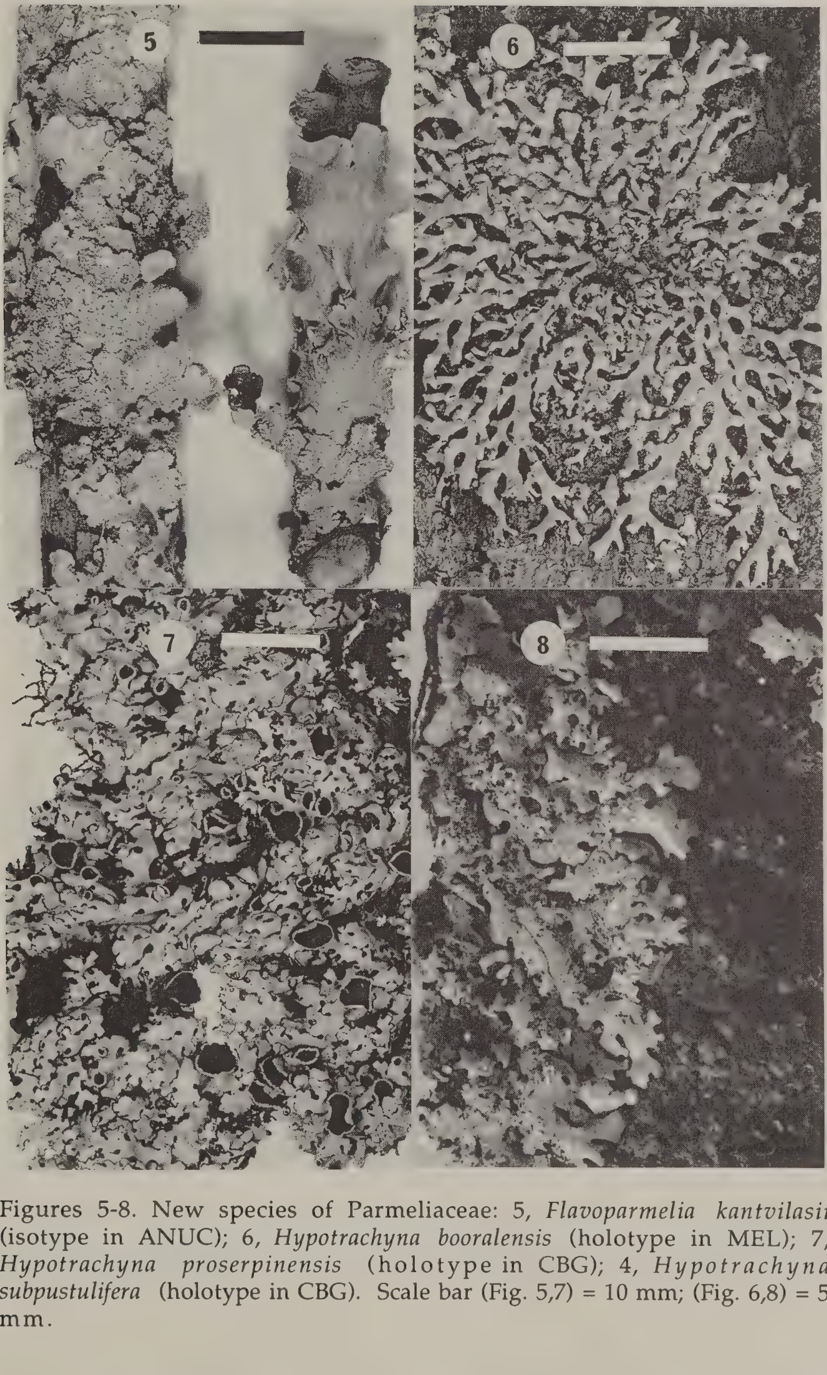
Thallus corticolous, adnate to tightly adnate, whitish mineral-grey, 2.5-4.0 cm diam. *Lobes* linear-elongate, separate to subimbricate, dichotomous to subirregularly divided, 0.5-1.0 mm wide, margins entire. *Upper surface* shiny, continuous, plane to slightly convex, emaculate, pustulate; pustules subapical, bursting open, eroding and becoming coarsely granular-sorediate with age and exposing black lower cortex. Medulla white. *Lower surface* black, moderately to densely rhizinate below and at the margins, rhizines black, shiny, dichotomously branched. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, medulla K- or K+ pale reddish, C- KC+ rose, P-; containing atranorin, chloroatranorin, colensoic acid (major), 4-*O*-methylphysodic acid (major), lividic acid (trace), physodic acid (minor), oxyphysodic acid (trace).

Superficially this new species resembles *Hypotrachyna pustulifera* (Hale) Hale as both species have erumpent pustules on the upper surface and contain components of the lividic acid-physodic acid chemosyndrome. However *H. pustulifera* is corticolous and has much larger thalli (4-6 cm diam.), broader lobes (2-3 mm wide) and contains lividic acid as the major secondary metabolite. *H. subpustulifera* by contrast is saxicolous, has smaller thalli (2.5-4.0 cm diam.), narrower lobes (0.5-1.0 mm wide) and contains 4-*O*-methylphysodic acid and colensoic acid as major secondary substances. This new species is known from several localities in New South Wales, growing on Hawksbury sandstone.

Specimens Examined

NEW SOUTH WALES. On sandstone rocks in heath, Peckmans Plateau, Katoomba, 980 m, *J. A. Elix 3211*, 24.iv.1977 (ANUC); on sandstone rocks in open *Eucalyptus* woodland, Morton National Park, 8 km north-east of Nerriga, 35°07'S, 150°08'E, 750 m, *J. A. Elix 11598 & P. W. James*, 20.i.1984 (ANUC).



Figures 5-8. New species of Parmeliaceae: 5, *Flavoparmelia kantvilasii* (isotype in ANUC); 6, *Hypotrachyna booralensis* (holotype in MEL); 7, *Hypotrachyna proserpinensis* (holotype in CBG); 4, *Hypotrachyna subpustulifera* (holotype in CBG). Scale bar (Fig. 5,7) = 10 mm; (Fig. 6,8) = 5 mm.

Neofuscelia kondininensis Elix sp. nov. Fig. 9

Species cum thallo ut in *Neofuscelia incantata* sed ab hac specie subto pallido differt.

Type: Australia. Western Australia. On exposed rocks in open scrubland, with scattered *Acacia* and *Eucalyptus*, 29 km east of Kondinin on road to Hyden, *J. A. Elix 21680 & M. V. Sargent*, 19.viii.1987; holo-CBG.

Thallus saxicolous, tightly adnate, yellowish brown to dark brown, 4-5 cm in diam. *Lobes* sublinear-elongate to subirregular, barely imbricate, 0.5-1.5 mm wide. *Upper surface* dull or slightly shining, smooth at the margins, becoming rugulose on older lobes, *isidiate*; isidia cylindrical, simple for the most part, seldom branched. *Lower surface* ivory to pale brown, moderately rhizinate, rhizines simple, to 0.3 mm long. *Pycnidia* rare, conidia not seen. *Apothecia* not seen.

Chemistry. Cortex K-, HNO_3+ dark blue-green; medulla K-, C-, KC+ rose-red, P-; containing physodic acid.

This new species closely resembles *Neofuscelia incantata* (Essl.) Essl. both morphologically and chemically, but differs in the colour of the lower surface. In *N. incantata* the underside is dark brown or black, but often paler at the apices whereas in *N. kondininensis* the lower surface is ivory to pale brown, but becoming darker at the apices. At present this new species is known only from the type collection.

Neofuscelia imatatricoides Elix sp. nov. Fig. 10

Species cum thallo ut in *Neofuscelia imitatrix* simili sed ab hac specie lobis accessoriis saepe subcylindrico et acido 4-*O*-methylphysodico, acido α-collatolico et acido alectoronico continente differt.

Type: Australia. New South Wales. On sandstone rocks in open *Eucalyptus* forest, Morton National Park, 8 km north-east of Nerriga, 35 07'S, 150 08'E, 760 m, *J. A. Elix-3062*, 30.iii.1977; CBG-holotype, MEL-isotype.

Thallus foliose, saxicolous, moderately adnate, dark brown to black-brown, paler at the periphery, 3-4 cm diam. *Lobes* sublinear-elongate, 0.6-1.0 (-1.2) mm wide, flat or slightly convex at the apices, becoming more strongly convex, cracked and areolate within the thallus, developing very narrow (0.1-0.4 mm wide), elongate, dichotomously divided secondary lobes at the periphery and within the thallus. The secondary lobes subfruticose to fruticose in habit, circular to subcircular in cross section and for the most part unattached to the substrate. *Upper surface* dull to slightly shiny at the apices, smooth at the apices but becoming markedly rugose within the thallus, lacking soredia and isidia. Medulla white. *Lower surface* jet black,

shining, sparsely rhizinate, rhizines black, short, simple or occasionaly tufted, slender. *Pycnidia* common, conidia bifusiform, 6-8 x 1 µm. *Apothecia* common, short stipitate, 1-3 mm in diam., disc black-brown, concave at first but becoming more or less flat or undulating, margin thin, entire; spores (8), colourless, ellipsoid, 7-9 x 3.5-5.5 µm.

Chemistry. Cortex K-, HNO+ dark blue-green, medulla K-, C-, P-; containing alectoronic acid (major), α-collatolic acid (major), 4-*O*-methylphysodic acid (major) and physodic acid (minor).

This new species appears to be related to *Neofuscelia imitatrix* (Taylor) Essl. since both species often develop distinctly pulvinate thalli with a black lower surface, and give similar chemical reactions. However they can be separated clearly by their morphology since the secondary lobes of *N. imitatricoides* are distinctly circular to subcircular in cross section while those of *N. imitatrix* are flat to weakly convex. The chemical profile of these two species also differs consistently since *N. imitatricoides* contains alectoronic acid, α-collatolic acid and 4-*O*-methylphysodic acid (all in substantial proportions) and physodic acid (traces or minor) while *N. imitatrix* contains physodic acid (major) together with occasional traces of 4-*O*-methylphysodic acid. Thus these two species appear to have overlapping chemistries (i.e. they belong to the same chemosyndrome) but maintain their chemical integrity even when sympatric and are considered distinct species (Elix 1982).

Neofuscelia parasitica Elix sp. nov. Fig. 11

Species cum thallo ut in *Neofuscelia pulla* sed ab hac specie acido glomelliferonico, acido loxodellonico et acido glomellonico continente differt.

Type: Australia. Australian Capital Territory. On sandstone rocks, Kowen forest, 16 km east of Canberra, 35°15'S, 149°16'E, 730 m, *J. A. Elix 1329,* 21.xi.1975; CBG-holotype.

Thallus small foliose, growing over thalli of *Neofuscelia verisidiosa* (Essl.) Essl. or *Neofuscelia loxodella* (Essl.) Essl., moderately adnate, olive-brown to reddish or dark brown, often paler at the periphery, to 2.0 cm diam. *Lobes* irregular to sublinear-elongate, 0.8-1.5 mm wide, contiguous to imbricate in part. *Upper surface* dull to slightly shiny at the apices, smooth, lacking soredia and isidia. Medulla white. *Lower surface* black, sometimes dark brown towards the apices, moderately to densely rhizinate, rhizines slender, simple, black. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, HNO_3+ dark blue-green, medulla K-, C-, KC+ rose, P-; containing glomelliferonic acid (major), loxodellonic acid (major), and glomellonic acid (trace).

This unique new species could be confused with *Neofuscelia delisea* (Duby) Essl. since both species lack isidia, have a black lower surface, and give comparable medullary spot tests. However, *N. delisea* contains glomelliferic acid, loxodellic acid and glomellic acid whereas *N. parasitica* contians the isostructural depsidones, glomelliferonic acid, loxodellonic acid and glomellonic acid. This chemistry has been observed previously in *N. subincerta* (Essl.) Essl. (an isidiate species) and *N. pyrenaica* (Essl.) Essl. (Elix, Jenkins & Jenie 1987). The latter species differs from *N. parasitica* in the much larger thalli (2-9 cm diam.), pale brown to black-brown lower surface and saxicolous substrate. At present *N. parasitica* has only been found growing over thalli of the common isidiate *Neofuscelia* species, *N. verisidiosa* and *N. loxodella*. Interestingly the former species produces medullary divaricatic acid, a depside unrelated structurally to the depsidones present in *N. parasitica*. At present this new species is only known from the type locality where it appears quite common.

Specimens Examined

AUSTRALIAN CAPITAL TERRITORY. Type locality, *J. A. Elix 921*, 13.vi.1975, *J. A. Elix 21807A*, 25.x.1987 (ANUC).

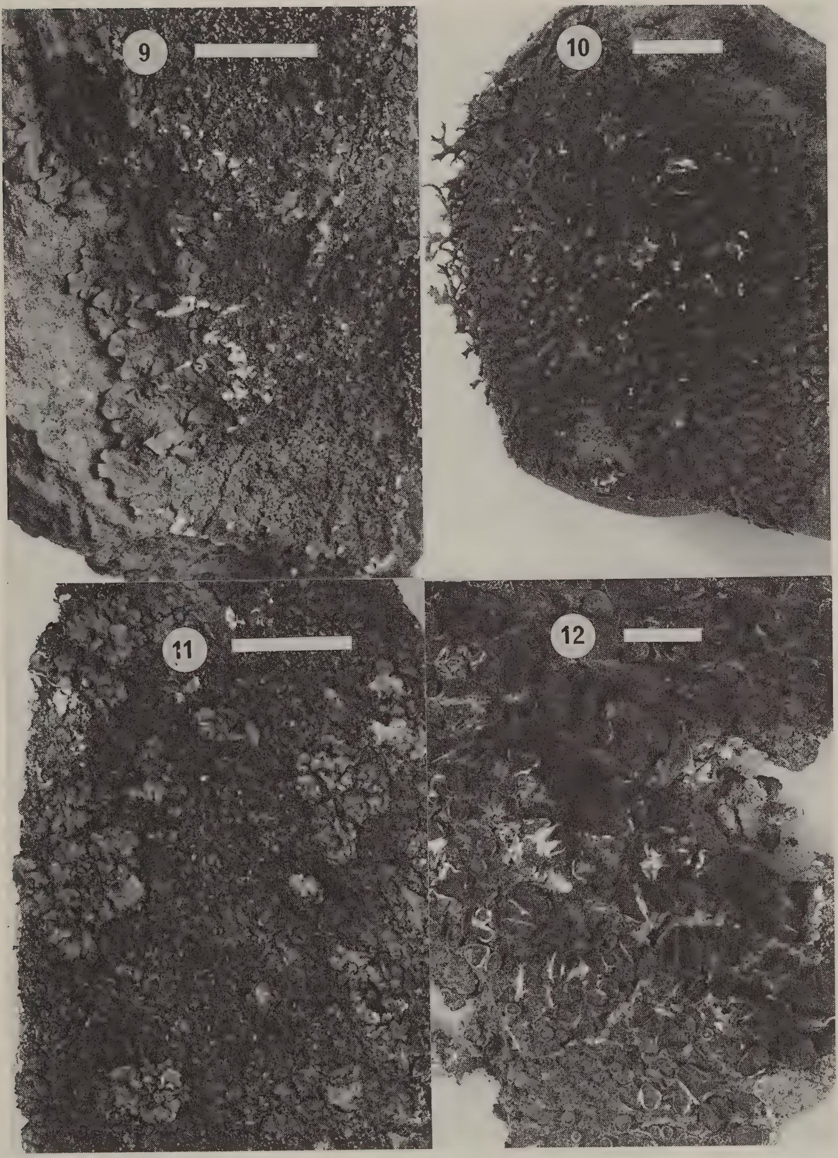
Neofuscelia scabrosina Elix sp. nov. Fig. 12

Species cum thallo ut in *Neofuscelia luteonotata* sed ab hac specie acido constipatico, acido protoconstipatico, scabrosini 4,4'-diacetate, scabrosini 4-acetate-4'-butyrate, scabrosini 4,4'-dibutyrate et acido ursolico continente differt.

Type: Australia. Western Australia. On soil and termite mounds at base of rock outcrop, Camels Peak, *N. Sammy*, 24.v.1972 ; holo-PERTH 810191.

Thallus foliose, terricolous, moderately adnate to the substrate, olive-brown or dark brown to black-brown, to 8 cm diam. *Lobes* irregular to sublinear-elongate, 1.0-3.0 mm wide, discrete to imbricate in part. *Upper surface* dull to slightly shiny and smooth at the apices but becoming markedly rugose within the thallus, lacking soredia and isidia. Medulla white. *Lower surface* pale tan to light brown, sometimes darkening towards the lobe apices, moderately to densely rhizinate, rhizines short, simple, concolorous with the lower surface or darkening. *Pycnidia* common, conidia bifusiform, sometimes only weakly so, 6-8 x 1 µm. *Apothecia* common, short stipitate, 3-5 mm in diam., disc black-brown, concave at first but becoming more or less flat or undulating, margin thin, entire; spores (8), colourless, ellipsoid, 6-9 x 3.5-5.5 µm.

Chemistry. Cortex K-, HNO+ dark blue-green, medulla K-, C-, P-; containing constipatic acid (major), protoconstipatic acid (major), scabrosin 4,4'-



Figures 9-12. New species of Parmeliaceae: 9, *Neofuscelia kondininensis* (holotype in CBG); 10, *Neofuscelia imatatricoides* (holotype in CBG); 11, *Neofuscelia parasitica* (holotype in CBG); 12, *Neofuscelia scabrosina* (holotype in PERTH). Scale bar = 5 mm.

diaceatate, scabrosin 4,4'-dibutyrate, scabrosin 4-acetate-4'-butyrate and ursolic acid.

This new species could be confused with *Neofuscelia luteonotata* (J. Stein.) Essl. since both species often occur on soil, have similar foliose thalli with a pale tan lower surface, and give completely negative medullary spot tests. The two species have slightly different general appearance which is difficult to define and positive identification must rely on chemical analysis. Thus *N. scabrosina* contains the fatty acids constipatic acid and protoconstipatic acid and three scabrosin derivatives while *N. luteonotata* contains stenosporic acid and/or divaricatic acid, sometimes with accessory gyrophoric acid. Furthermore *N. scabrosina* has a very limited distribution (Western Australia) while *N. luteonotata* is widely distributed in southern Europe, north and south Africa as well as Australia. Given the divergent distributions and unrelated chemistry these two taxa are considered distinct species (Elix 1982). Chemically this new species most closely resembles *N. scabrella* (Essl.) Essl. from South Africa, but the latter species lacks the fatty acids, and is distinguished morphologically by the elongate, dichotomously branched, loosely entangled lobes. At present this new species is only known from the type locality.

Specimen Examined

WESTERN AUSTRALIA. Type locality, *N. Sammy*, 24.v.1972 (PERTH).

Neofuscelia subbarbatica Elix sp. nov. Fig. 13

Species cum thallo ut in *Neofuscelia parviloba* sed ab hac specie thallo crassiore et acido barbatico, acido 4-*O*-demethylbarbatico et acido norobtusatico continente differt.

Type: Australia. Western Australia. On low granite rocks in sclerophyll forest, 40 km south-east of Armadale, beside the Albany highway, *G. Rambold 5276*, 1.iv.1986 ; holo-M.

Thallus small foliose or becoming subcrustose in the centre, tightly adnate, dark brown, 1-4 cm in diam. but coalescing into larger patches. *Lobes* sublinear to irregular, 0.2-0.8 mm wide. *Upper surface* more or less smooth at the periphery, convex within and becoming fissured and rugose to subareolate, dull throughout or slightly shiny at the apices, without isidia. Medulla white. *Lower surface* pale tan to pale brown, smooth and more or less dull, in part attached directly to the substrate, elsewhere sparsely rhizinate, the rhizines concolorous or darkening, small and fine, to 0.2 mm long. *Pycnidia* common, conidia weakly bifusiform, 5-6 x 1 µm. *Apothecia* common, sessile or short stipitate, concave at first but becoming more or less flat or undulating, to 0.5-2.0 mm in diam., margin entire; spores (8), colourless, ellipsoid, 7-9 x 4-6 µm.

Chemistry. Cortex K-, HNO_3+ dark blue-green; medulla K-, C-, KC+ yellow, P-; containing barbatic acid (major), norobtusatic acid (minor), 4-*O*-demethylbarbatic acid (trace).

Morphologically this new species closely resembles *Neofuscelia parviloba* (Essl.) Essl. in the diminutive subcrustose thalli, the pale lower surface and the absence of isidia. However *N. parviloba* has a flatter, thinner thallus and contains fumarprotocetraric acid and protocetraric acid. *N. melanobarbatica* (Essl.) Essl. the only other barbatic acid containing *Neofuscelia* with a pale lower surface is distinctly foliose and loosely adnate. At present this new species is only known from the type collection.

Paraparmelia yamblaensis Elix sp. nov. Fig. 14

Species cum thallo ut in *Paraparmelia lithophiloides* sed ab hac specie thallo laxe adnato, lobi latioribus et acido norstictico et acido salazinico noncontinente differt.

Type: Australia. New South Wales. On rocks in grassland, Great Yambla Ridge, 17 km south-south-east of Culcairn, 35°50'S, 147°04'E, 580 m, *J. A. Elix 23095*, 16.xi.1989; holo: CBG, iso: MEL.

Thallus foliose, loosely adnate on rocks, pale mineral grey but darkening with age, irregularly lobate, 6-8 cm in diam. *Lobes* variable, irregular to sublinear-elongate, moderately to sparingly imbricate, 2.0-3.0 (-5.0) mm wide, the apices crenulate, more or less rotund, occasionally developing narrower (0.5-1.5 mm), subdichotomously divided secondary lobes. *Upper surface* dull, emaculate, lacking soredia and isidia, darkening with age, the margins commonly blackened. Medulla white. *Lower surface* jet black except for a narrow brown marginal zone, very sparsely rhizinate, rhizines concolorous with the lower surface, simple, short, slender. *Pycnidia* rare; conidia bifusiform, 6-9 x 1 µm. *Apothecia* scattered, adnate, 3-8 mm in diam.; disc concave then undulate-distorted, brown to black-brown, margin thick and involute at first, then thin, persistent; spores (8), colourless, ellipsoid, 7-8 x 5-6 µm.

Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; containing atranorin.

This new species is characterised by the large, loosely adnate thalli, the broad sublinear lobes with a black lower surface which lack isidia, and the absence of medullary chemistry. The more adnate portions of the thallus resemble *P. lithophiloides* (Kurok.) Elix & Johnston, but that species has narrower lobes (1-2 mm wide), denser rhizines and contains the medullary depsidones, norstictic acid and salazinic acid. *P. yamblaensis* is only known from the type locality where it is particularly common.

Specimens Examined

NEW SOUTH WALES. Type locality, *J. A. Elix 23106,* 16.xi.1989 (ASU, PRE); *J. A. Elix 23122, J. A. Elix 23123,* 16.xi.1989 (ANUC)

Parmelia crowii Elix sp. nov. Fig. 15

Species cum thallo ut in *Parmelia erumpens* sed ab hac specie isidiis coralloidibus et esorediatis differt.

Type: Australia. New South Wales. Brigadoon Farm, Bunga, 18 km south of Bermagui, 36°34'S, 150°03'E, 30 m, *J. A. Elix 23373,* 2.xii.1989; holo: CBG; iso ANUC, HO. MEL, PRE.

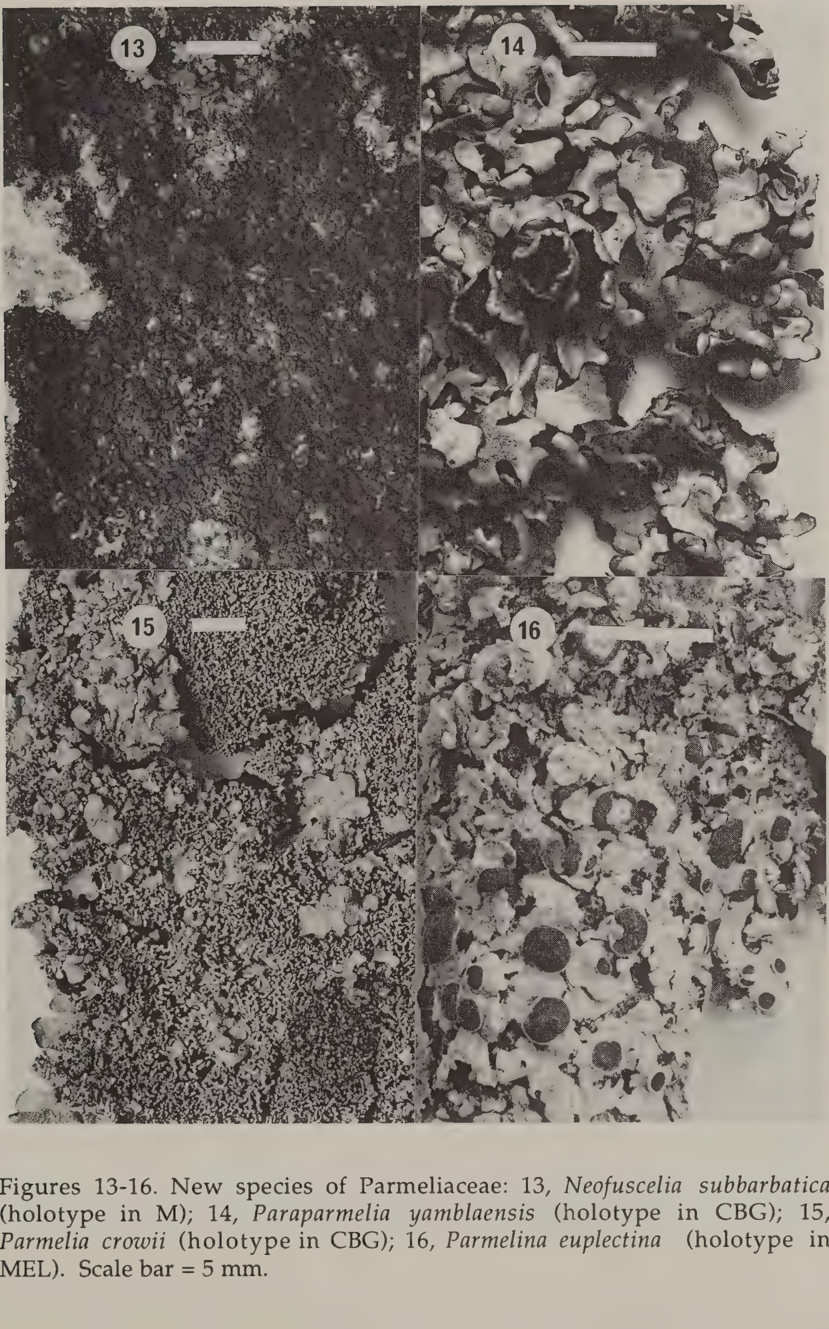
Thallus saxicolous, adnate to loosely attached, pale mineral-grey, 8-20 cm in diam. *Lobes* short, subirregular to apically rotund, imbricate, 2-5 mm wide. *Upper surface* shiny, plane, white-reticulate at first but becoming conspicuously cracked to the margin, pseudocyphellae effigurate, somewhat raised, dense, fusing into a reticulate network over the whole surface, *isidiate*; the isidia epicorticate, coarse, cylindrical at first then coralloid, rarely bursting apically and not becoming granular and sorediose. *Lower surface* moderately rhizinate, rhizines simple or squarrosely branched, 1-2 mm long. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow; medulla K+ yellow then deep red, C-, P+ red-orange; containing atranorin, chloroatranorin, salazinic acid (major), consalazinic acid (minor), norstictic acid (trace).

This new species closely resembles *P. erumpens* Kurok. except in the develpment of asexual propagules. Thus *P. erumpens* is sorediate-isidiate where the coarse granular soredia become in part corticate, forming dense marginal and laminal soralia and/or extended, granular, coralloid-isidioid outgrowths while in *P. crowii* the coarse cylindrical isidia become densely coralloid branched, but only very rarely burst open and then do not become sorediate. *Parmelia pseudotenuirima* Gyelnik, another Australian species with cylindrical isidia, differs in having much thinner (less than 0.05 mm vs. 0.2-0.3 mm thick), syncorticate isidia. This new species is named in honour of Dr. W. D. Crow, friend, colleague and owner of Brigadoon Farm.

Parmelina euplectina Kurok. ex. Elix sp. nov. Fig. 16

Species cum thallo ut in *Parmelina pseudorelicina* sed ab hac specie medulla inferiore pigmento ochraceo et euplectino continente differt.



Figures 13-16. New species of Parmeliaceae: 13, *Neofuscelia subbarbatica* (holotype in M); 14, *Paraparmelia yamblaensis* (holotype in CBG); 15, *Parmelia crowii* (holotype in CBG); 16, *Parmelina euplectina* (holotype in MEL). Scale bar = 5 mm.

Type: Australia. New South Wales. On *Casuarina* species, Raymond Terrace to Buladelah road, 30 km north of Karuah, *R. Filson 7176*, 9.v.1965; holo: MEL.

Thallus corticolous, adnate to tightly adnate, pale grey to grey-green, 2-4 cm diam. *Lobes* sublinear-elongate, generally narrow but occasionally more robust, 1.0-3.0 mm wide, irregularly branched, imbricate, margins sinuous, shining, black, ciliate, the cilia sparse, black, simple, short, 0.1-0.3 mm long, mainly in the axils of the lobes. *Upper surface* shiny, plane or weakly foveolate at first, becoming rugulose with age, emaculate, lacking soredia and isidia. Upper medulla white, lower medulla orange-yellow. *Lower surface* black, with a narrow, brown, naked marginal zone, moderately to sparsely rhizinate, rhizines simple, black. *Pycnidia* numerous, conidia cylindrical to weakly fusiform, 6-7 x 0.7 μm. *Apothecia* common, sessile to substipitate, 1-2.5 mm diam., disc concave, margin thin, entire, not crenulate or inflexed, thalline exciple smooth; spores (8), colourless, ellipsoid, 9-13 x 6-7 μm.

Chemistry. Cortex K+ yellow, medulla K-, C+ red, P-, lower medulla K+ purple; containing atranorin, chloroatranorin, lecanoric acid (major), euplectin.

Although this new species closely resembles *Parmelina pseudorelicina* (Jatta) Kantvilas & Elix, it is clearly distinguished by the partially orange-yellow pigmented lower medulla due to the presence of the anthraquinone, euplectin. To date this is the only species of *Parmelina* known with a pigmented medulla. This species was formerly referred to as *Parmelia jejunga* Kurok. but the latter is a nomen nudum (Filson 1983). *P. euplectina* is a very rare endemic species, currently known only from the type locality.

Parmelina johnstoniae Elix sp. nov. Fig. 17

Species cum thallo ut in *Parmelina conlabrosa* sed ab hac specie thallo brunneo-cinerascens, fragiliore et acido protolichesterinico et acido lichesterinico continente differt.

Type: Australia. New South Wales. On trunk of *Acacia*, Buckenbowra River Estuary, 7.5 km W of Batemans Bay, 34°42'S, 150°06'E, 5 m, *J. Johnston 2610*; holo: CBG.

Thallus corticolous or lignicolous, adnate, brownish-grey to pale mineral grey, 2-6 cm in diam. *Lobes* variable, sublinear-elongate to subirregular and apically subrotund, 1-3 mm wide, sometimes subdichotomously branched, marginal cilia moderate to sparse and concentrated in the lobe axils, simple. *Upper surface* shiny, emaculate, more or less plane, moderately to densely isidiate, the isidia cylindrical, erect, often branched, less than 0.5 mm high. Medulla white. *Lower surface* black, moderately rhizinate, the rhizines black, shiny simple. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow, medulla K-, C-, KC-, P-; containing atranorin, chloroatranorin, lichesterinic acid, protolichesterinic acid.

This new species is distinguished by the cylidrical isidia and medullary chemistry. Morphologically this species closely resembles the common *P. conlabrosa* (Hale) Elix & Johnston but differs in the browner, more fragile thallus and the negative medullary reactions. *P. conlabrosa* contains medullary lecanoric acid. *P. johnstoniae* is probably the isidiate counterpart of *P. endoleuca* (Taylor) Hale. At present this new species is only known from the type locality where it appears quite common. This species is named in honour of my former colleague, Ms. Jen Johnston.

Specimens Examined

NEW SOUTH WALES. Type locality, *J. A. Elix 10978*, 29.v.1983, *J. A. Elix 22618*, 4.viii.1988 (ANUC).

Parmelinopsis protocetrarica Elix sp. nov. Fig. 18

Species cum thallo ut in *Parmelinopsis minarum* sed ab hac specie subtus pallido et acido protocetrarico continente differt.

Type: Australia. Queensland. On mossy trunk of felled tree in rainforest, Walter Hill Range, 26 km south-east of Ravenshoe, 17°46'S, 145°41'E, 800 m, *J. A. Elix 17041 & H. Streimann*, 2.vii.1984; holo: CBG.

Thallus corticolous, adnate, whitish to pale greenish mineral grey, 2-4 cm diam. *Lobes* sublinear-elongate, contiguous, 0.8-1.2 mm wide, the marginal cilia irregularly dispersed, simple, to 0.7 mm long. *Upper surface* shiny, sparingly maculate at the apices, plane, densely isidiate, the isidia cylindrical, erect, often branched, to 0.5 mm high, becoming procumbent and flattened with age. Medulla white. *Lower surface* ivory to pale brown, black-brown at the apices, moderately rhizinate, the rhizines black, shiny, simple or squarrose branched. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K+ yellow medulla K-, C+ rose, KC+ red, P+ orange; containing atranorin, gyrophoric acid (minor), protocetraric acid (major), unknown (minor).

Morphologically this new species superficially resembles *Parmelinopsis minarum* (Vainio) Elix & Hale with fragile thalli with densely isidiate narrow lobes. However *P. protocetrarica* is clearly distinguished by the pale lower surface of the lobes (black in *P. minarum*) and the presence of additional protocetraric acid in the medulla. At present this new species is only known from the type collection.

Parmotrema submerrillii Elix sp. nov. Fig. 19

Species cum thallo ut in *Parmotrema merrillii* sed ab hac specie lobis sine laciniis marginalibus differt.

Type: Australia. Queensland. On tree in picnic area adjacent to rainforest, Mt. Spec National Park, ridge on the Loop, on the Paluma road, WNW of Townsville, 1000 m, *M. E. Hale 64052*, 28.vii.1983; holo: CBG.

Thallus corticolous, loosely adnate, coriaceous, pale mineral grey or darkening with age, 8-10 cm diam. *Lobes* irregular, 5-15 mm wide, with rotund apices, margins ciliate, cilia prominent, 1.0-3.5 mm long. *Upper surface* emaculate, lacking soredia and isidia. Medulla white. *Lower surface* black, marginal rim brown, sparsely rhizinate, rhizines simple, black. *Pycnidia* common, conidia sublageniform, 5-6 x 1 µm. *Apothecia* common, stipitate, 4-8 mm diam., imperforate, the exciple dentate. ciliate, amphithecium rugose, white maculate; spores (8), colourless, ellipsoid, 25-34 x 12-16 µm.

Chemistry. Cortex K+ yellow, medulla K-, C-, KC-, P+orange-red; containing atranorin, chloroatranorin, protocetraric acid (major).

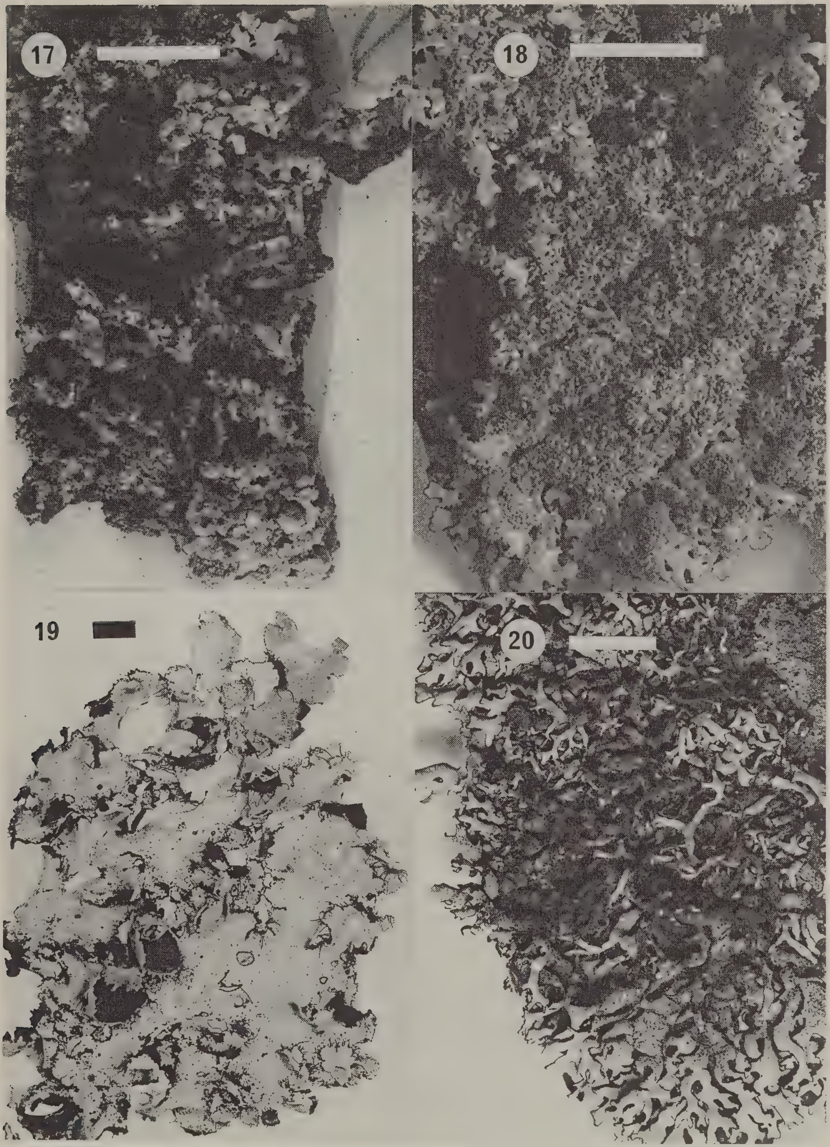
This new species resembles the south-east Asian species, *P. merrillii* (Vainio) Hale both chemically and morphologically. However where *P. merrillii* develops long narrow laciniae on the lobes and frequently on the exciple of the apothecia, these are absent in *P. submerrillii,* although the exciple is dentate in the latter. This species may also be confused with *P. zollingeri* (Hepp) Hale as they have similar thalli and contain protocetraric acid. However *P. zollingeri* has very sparse, short (less than 1 mm) cilia, smaller spores (18-22 x 8-10 µm) and an eciliate exciple. At present this new species is only known from the type locality.

Xanthoparmelia austrocostrictans Elix sp. nov. Fig. 20

Species cum thallo ut in *Xanthoparmelia constrictans* sed ab hac specie superne emaculata et rhizinis modicis differt.

Type: Australia. New South Wales. On sandstone rocks in open *Eucalyptus* woodland, Morton National Park, 8 km north-east of Nerriga, *J.A. Elix 3070;* CBG-holotype.

Thallus foliose, moderately to loosely adnate to rocks or soil, yellow-green in colour darkening with age, 5-7 cm in diam. *Lobes* linear-elongate, dichotomously to subdichotomously branched, moderately to



Figures 17-20. New species of Parmeliaceae: 17, *Parmelina johnstoniae* (*J. A. Elix 10978* in ANUC); 18, *Parmelinopsis protocetrarica* (holotype in CBG); 19, *Parmotrema submerrillii* (holotype in CBG); 20, *Xanthoparmelia austroconstrictans* (holotype in CBG). Scale bar = 5 mm

sparingly imbricate, 0.4-1.5 mm wide but often irregularly widened and constricted. *Upper surface* smooth, shiny, emaculate, lacking soredia and isidia but with numerous pycnidia, margins black; medulla white. *Lower surface* jet black but brown at the tips of the lobes, moderately rhizinate, rhizines simple or tufted. *Pycnidia* common; conidia bifusiform, 5-8 x 0.7 µm. *Apothecia* not seen.

Chemistry. Cortex K-, medulla K+ yellow becoming deep red, C-, P+ orange; containing usnic acid, salazinic acid and consalazinic acid.

X. austroconstrictans is distinguished by the loosely imbricate, linear elongate lobes which are irregularly constricted and the production of salazinic acid in the medulla. Chemically *X. austroconstrictans* is identical with *X. rubrireagens* - a morphologically similar species. However the lobes of *X. rubrireagens* tend to be much more uniform in width (i.e. not irregularly constricted) and the underside is sparsely rhizinate and often erhizinate towards the apices, the lower surface rugose and wrinkled, and the rhizines themselves short, robust and ± tufted. By contrast *X. austroconstrictans* is moderately rhizinate, with ± subapically grouped rhizines and the lower surface is more or less plane. This new species also resembles the South African *X. constrictans* (Nyl.) Hale - a species which differs in having a maculate upper surface and dense, long, ± branched, curved rhizines commonly projecting beyond the margins of the lobes. *X. austroconstrictans* is a rare species in Australia, being restricted to the mountains of south-eastern Australia (New South Wales and Victoria) and Tasmania.

Specimen Examined

VICTORIA. Bullock Creek, 16 km south of Bendigo along Calder Highway, *J. Johnston 1162A* (ANUC). TASMANIA. Royal George Mine area, *G.C. Bratt 345* (HO).

Xanthoparmelia canobolasensis Elix sp. nov. Fig. 21

Species cum thallo ut in *Xanthoparmelia glareosa* sed ab hac specie thallo sparsim rhizinato, rhizinis simplicibus et acido hypostictico et acido hyposalazinico continente differt.

Type: Australia. New South Wales. On volcanic rock ledge in open *Leptospemum* scrub, west slope of Mt. Canobolas, 8 km south-west of Orange, 32°21'S, 148°59'E, 1300 m, *J. Johnston 2909*, 6.xii.1989; holo: CBG.

Thallus foliose, adnate to tightly adnate, saxicolous or terricolous, yellow-green but becoming greyish with age, 5-10 cm in diam. *Lobes* subirregular, elongate, imbricate, 1.0-3.0 mm wide, with distinct black margins; secondary lobes 0.4-1.0 mm wide, subdichotomously branched, overlying the centre of the thallus but sometimes becoming dominant. *Upper surface* dull or commonly shiny, emaculate, more or less smooth, lacking soredia and isidia; medulla white. *Lower surface* black, brown-black at the apices, sparsely rhizinate, rhizines simple, concolorous with the lower surface. *Pycnidia* common, conidia bifusiform 5-7 x 1 µm. *Apothecia* sessile, 2.0-4.0 mm in diam., concave; disc cinnamon-brown, margin thin, strongly involute at first but becoming crenulate and lacerate; spores (8), colourless, ellipsoid, 7-10 x 5-6 µm.

Chemistry. Cortex K-; medulla K+ yellow becoming red, C-, KC-, P+ yellow-orange; containing usnic acid, norstictic acid (major), connorstictic acid (minor), hypostictic acid (minor/trace), and hyposalazinic acid (trace).

This new species resembles *X. glareosa* (Kurok. & Filson) Elix & Johnston in growth form and chemistry, but *X. glareosa* is moderately rhizinate with simple and dichotomously branched rhizines and contains medullary salazinic acid in addition to norstictic and connorstictic acids whereas *X. canobolasensis* is sparsely rhizinate, has simple rhizines and contains hypostictic and hyposalazinic acids in addition to norstictic and connorstictic acids.

Specimen Examined

NEW SOUTH WALES. On soil in grassy area, Orange View, Pinnacles Road, Mt. Canobolas, 1100 m, *M. E. Hale 59947*, 25.ii.1984 (ANUC).

Xanthoparmelia hyposalazinica Elix sp. nov. Fig. 22

Species cum thallo ut in *Xanthoparmelia subnuda* sed ab hac specie lobis sublineariter elongatis et acidum hyposalazinicum continente differt.

Type: Australia. Australian Capital Territory. On porphyry rocks in pasture, 0.8 km west of Coppins Crossing, 8 km west of Canberra, 35°17'S, 149°03'E, 520 m, *J. A. Elix A1753*, 17.v.1992; holo: CBG.

Thallus foliose, loosely adnate on rocks, yellowish-green, 3-5 cm in diam. *Lobes* sublinear-elongate, di- or trichotomously branched, imbricate, often ascending at the apices, 0.5-1.5 mm wide. *Upper surface* smooth, glossy or opaque, emaculate, often blackened at the margins, lacking soredia and isidia; medulla white. *Lower surface* black, nude or sparsely rhizinate, rugulose, rhizines simple, black, robust, 0.2-1.0 mm long. *Pycnidia* common; conidia bifusiform, 5-7 x 1 µm. *Apothecia* sessile to substipitate, 2-4 mm in diam., margins undulate or not, disc dark brown, thalline exciple smooth, emaculate; spores (8), colourless, ellipsoid, 9-12 x 5-7 µm.

Chemistry. Cortex K-, medulla K+ yellow then red, C-,KC-, P+ yellow; containing usnic acid and hyposalazinic acid.

Its narrow, sublinear-elongate lobes, lack of maculae, soredia and isidia together with the black lower surface and medullary hyposalazinic acid distinguish this species. *X. subnuda* (Kurok.) Elix, a related species, has more linear-elongate lobes and contains medullary norstictic acid and connorstictic acid. Currently this rare endemic species is only known from the type locality.

Xanthoparmelia masonii Elix sp. nov. Fig. 23

Species cum thallo ut in *Xanthoparmelia mougeotina* sed ab hac specie thallo subtus brunneo differt.

Type: Australia. New South Wales. On granite outcrops in pasture with *Eucalyptus, M. E. Hale 59,276,* 10.i.1982; holo: CBG.

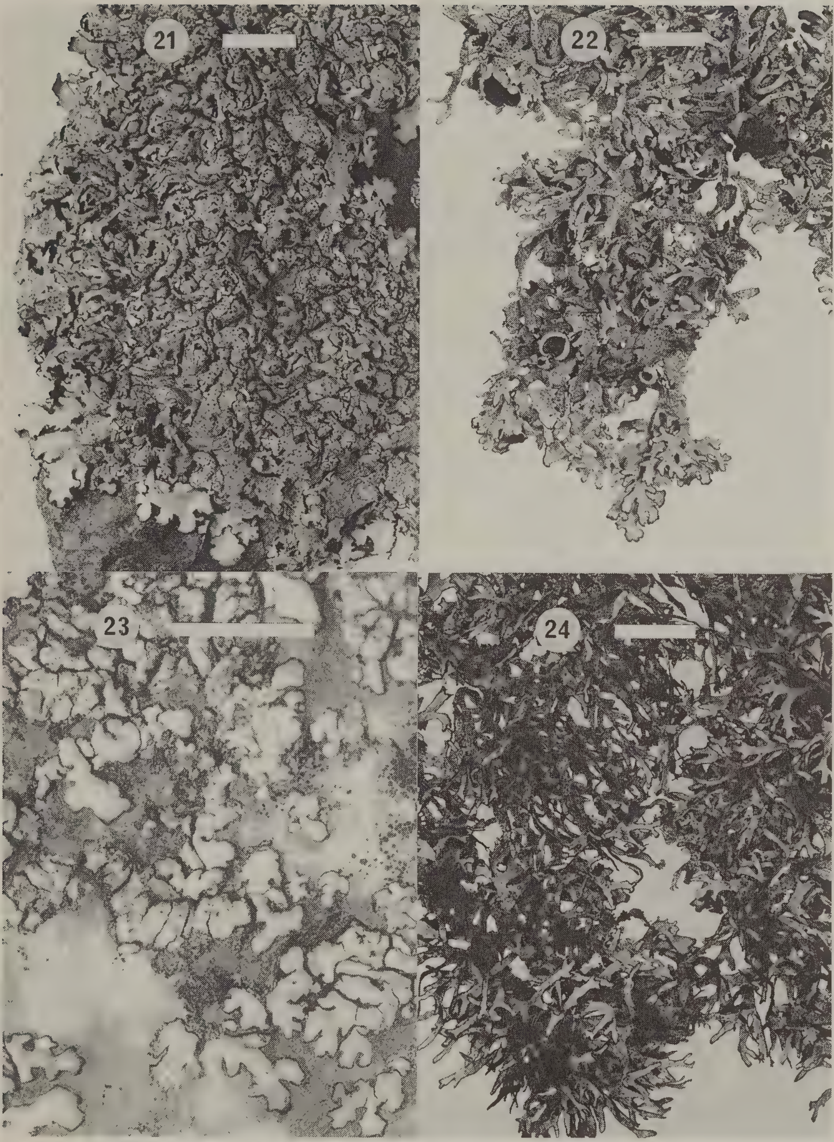
Thallus small foliose to subcrustose, tightly appressed on rocks, greenish-yellow in colour, subirregularly lobate or becoming almost subcrustose towards the centre, 3-6 cm in diam. *Lobes* sublinear, discrete or contiguous, 0.3-1.0 mm wide, older lobes irregularly fractured and areolae commonly formed. *Upper surface* opaque, emaculate, often tangentially cracked, moderately to sparsely *isidiate,* the isidia cylindrical, mainly simple; medulla white. *Lower surface* ivory to pale brown but often straw-yellow near the apices of the lobes, moderately rhizinate, the rhizines simple, pale brown. *Pycnidia* and *apothecia* not seen.

Chemistry. Cortex K-, medulla K+ yellow, C-, KC-, P+ orange; containing usnic acid, stictic acid, constictic acid, norstictic acid (minor), cryptostictic acid (trace), rarely menegazziaic acid (± trace), and associated unknown (± trace).

Morphologically this species closely resembles *X. mougeotina* (Nyl.) D. Gall. in that both lichens have tightly adnate thalli, contiguous lobes, cylindrical isidia and medullary stictic acid. However *X. mougeotina* is readily distinguished by the black lower surface. Another related species, *X. victoriana* Elix & Johnston has a pale lower surface, but is distinguished by the inflated, erumpent isidia. At present this new species is known only from the type collection.

Xanthoparmelia trirosea Elix sp. nov. Fig. 24

Species cum thallo ut in *Xanthoparmelia multipartita* sed ab hac specie lobi lineariter angustatis, modice imbricatis et acido hypoconstictico adjectus continente differt.



Figures 21-24. New species of Parmeliaceae: 21, *Xanthoparmelia canobolasensis* (holotype in CBG); 22, *Xanthoparmelia hyposalazinica* (holotype in CBG); 23, *Xanthoparmelia masonii* (holotype in CBG); 24, *Xanthoparmelia trirosea* (isotype in ANUC). Scale bar (Figs. 21, 22, 24) = 5 mm; (Fig. 23) = 2 mm.

Type: Australia. Australian Capital Territory. On granite rocks in open woodland, Gudgenby River Gorge, 4.5 km south of Tharwa, 35°34'S, 149°04'E, 620 m, *J. A. Elix 10165*, 12.iv.1982; holo: CBG, iso: ANUC, MEL [J. A. Elix : Lichenes Australasici Exsiccati, No. 19, distributed as *Parmelia multipartita* (R. Br. ex. Crombie) Elix].

Thallus foliose, very loosely adnate on rocks, yellow to yellow-green but blackening with age, 6-9 cm in diam. *Lobes* linear-elongate, subdichotomously branched, divaricate in places, moderately imbricate, becoming suberect and exposing the black lower surface, 0.5-1.0 mm wide. *Upper surface* smooth, shiny, emaculate, lacking soredia and isidia but with black margins; medulla white. *Lower suface* jet black, wrinkled, with very sparse rhizines or rhizines absent, rhizines simple, short, robust. *Pycnidia* common; conidia bifusiform, 5-7 x 1 µm. *Apothecia* adnate, 1.0-3.0 (-10.0) mm in diam., disc chestnut brown at first but darkening with age, margin entire, thick and involute at first but becoming thin and subentire with age; spores (8), colourless, ellipsoid, 6-10 x 3.5-5.5 µm.

Chemistry. Cortex K-, medulla K+, pale reddish, C-, KC-, P-; containing usnic acid, hypostictic acid, hyposalazinic acid, hypoconstictic acid .

This species has previously been confused with *Xanthoparmelia multipartita* (Crombie) Hale, but these two taxa show consistent morphological and chemical differences. *X. multipartita* differs morphologically in having more densely imbricate lobes and marginal lobes with a brown lower surface, whereas the thalli of *X. trirosea* are only moderately imbricate and the lower surface is jet black to the margins. Chemically *X. trirosea* contains hypoconstictic acid in addition to hypostictic acid and hyposalazinic acid observed in *X. multipartita*. The name of this species refers to the three rose-red spots which develop on a TLC plate after spraying with 10% sulfuric acid and charring. The latter species also contains minor or trace amounts of 4-*O*-methylhypoprotocetraric acid which is absent in *X. trirosea*. This new species occurs on exposed, acidic rocks in areas of moderate rainfall in coastal and hinterland areas of south-eastern Australia (N.S.W., A.C.T., Tas.).

Specimens Examined
NEW SOUTH WALES: On granite rocks, 10 km N of Jindabyne along the Cooma road, *J. A. Elix 1653, 1654, 1818*, 21.i.1976 (ANUC). TASMANIA: On granite rocks along the foreshore, Bicheno, *J. A. Elix 5531*, 13.i.1979 (ANUC).

New Combinations and Name

Bulbothrix queenslandica (Elix & Stevens) Elix, comb. nov.

Basionym: *Parmelia queenslandica* Elix & Stevens, Aust. J. Bot. **27**: 873 (1979).

Bulbothrix subtabacina (Elix) Elix, comb. nov.

Basionym: *Parmelia subtabacina* Elix, in Elix & Stevens, Aust. J. Bot. **27**: 875 (1979).

Canoparmelia owariensis (Asah.) Elix, comb. nov.

Basionym: *Parmelia owariensis* Asah., J. Jap. Bot. **28**: 135 (1953).

Canoparmelia pustulescens (Kurok.) Elix, comb. nov.

Basionym: *Parmelia pustulescens* Kurok. in Hale & Kurok., Contrib. U.S. Nat. Herb. **36**: 156 (1964).

Canomaculina melanochaeta (Kurok.) Elix, comb. nov.

Basionym: *Parmelia melanochaeta* Kurok. in Hale & Kurok., Contrib. U.S. Nat. Herb. **36**: 133 (1964).

Imshaugia evernica (Elix & Johnst.) Elix, comb. nov.

Basionym: *Parmeliopsis evernica* Elix & Johnst., Mycotaxon **31**: 495 (1988).

Parmotrema pseudovirens (Gyelnik) Elix, comb. nov.

Basionym: *Parmelia pseudovirens* Gyelnik, Fedde, Repert. Spec. Nov. **29**: 288 (1931).

Rimeliella haitiensis (Hale) Elix, comb. nov.

Basionym: *Parmelia haitiensis* Hale, Bryologist, **62**: 20 (1959).

Xanthoparmelia xanthofarinosa Elix , nom. nov.

Thallus adnatus vel arcte adnatus, saxicola, flavovirens, 3-5 cm diametro; lobi sublineares vel subirregulares, 0.5-2.0 mm lati. Superfices nitida, emaculata, dense sorediata, soraliis globoso-capitatis, confluentibus, et sorediis farinosis; superfices inferior castanea sed apices loborum versus saepe atrobrunnescens, modice rhizinata. Thallus acidum usnicum, acidum constipaticum, acidum protoconstipaticum, loxodinum, conloxodinum, norlobaridonum, conorlobaridonum et substantia ignota continens.

Type: Australia. Australian Capital Territory. On sandstone rocks, Kowen Forest, 16 km east of Canberra, 730 m, *J. A. Elix 1830;* holo: MEL; iso: CBG.

= *Parmelia xanthosorediata* Elix (nomen nudum, Chester & Elix 1979).

= *Xanthoparmelia xanthosorediata* (Elix) Elix & Johnston, *Bull. Br. Mus. nat. Hist. (Bot.)* **15**: 357 (1986) (nomen nudum, Begg, Chester & Elix 1979).

ACKNOWLEDGEMENTS

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LITERATURE CITED

Begg, W. R., Chester, D. O. & Elix, J. A. (1979). The structure of conorlobaridone and conloxodin. New depsidones from the lichen *Xanthoparmelia xanthosorediata*. *Aust. J. Chem.* **32**: 927-929.

Chester, D. O. & Elix, J. A. (1979). Three new aliphatic acids from lichens of genus *Parmelia* (subgenus *Xanthoparmelia*). *Aust. J. Chem.* **32**: 2565-2569.

Culberson, C. F. (1972). Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromatogr.* **72**: 113-125.

Culberson, C. F.. Culberson, W. L. and Johnson, A. (1981). A standardized TLC analysis of β-orcinol depsidones. *Bryologist* **84**: 16-29.

Culberson, C. F. and Johnson, A. (1982). Substitution of methyl *tert.*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *J. Chromatogr.* **238**: 483-487.

Elix, J. A. (1982). Peculiarities of the Australasian lichen flora: accessory metabolites, chemical and hybrid strains. *J. Hattori Bot. Lab.*, **52**: 407-415.

Elix, J. A., Jenie, U. A. & Jenkins, G. A. (1987). Three new depsidones from the lichen *Neofuscelia subincerta*. *Aust. J. Chem.* **40**: 2031-2036.

Elix, J. A. & Johnston, J. (1986). New Species of *Relicina* (Lichenized Ascomycotina) from Australasia. *Mycotaxon*, **27**: 611-616.

Elix, J. A. & Johnston, J. (1987a). New Species of *Paraparmelia* (Lichenised Ascomycotina) from Australia and New Zealand. *Brunonia* 1986, **9**: 139-153.

Elix, J. A. & Johnston, J. (1987b). New species of *Parmelina* (Lichenised Ascomycotina) from Australia and New Zealand. *Brunonia* 1986, **9**: 155-161.

Elix, J. A. & Johnston, J. (1987c). New species and new records of *Xanthoparmelia* (Lichenized Ascomycotina) from Australia. *Mycotaxon* **29**: 359-372.

Elix, J. A. & Johnston, J. (1988a). New species in the lichen family Parmeliaceae (Ascomycotina) from the Southern Hemisphere. *Mycotaxon* **31**: 491-510.

Elix, J. A. & Johnston, J. (1988b). New species in the lichen genus *Paraparmelia* (Ascomycotina) from the Southern Hemisphere, *Mycotaxon* **32**: 399-414.

Elix, J. A. & Johnston, J. (1988c). New Species and new reports of *Flavoparmelia* (lichenized Ascomycotina) from the Southern Hemisphere, *Mycotaxon* **33**: 391-400.

Elix, J. A., Johnston, J. & Armstrong, P. M. (1986a). A revision of the lichen genus *Xanthoparmelia* in Australasia. *Bull. Br. Mus. nat. Hist. (Bot.)* **15**: 163-362.

Elix, J. A., Johnston, J. and Parker, J. L. (1987). A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances (Aust. Nat. University, Canberra).

Elix, J. A., Johnston, J. and Parker, J. L. (1988). A Computer Program for the Rapid Identification of Lichen Substances. *Mycotaxon* **31**: 89-99.

Filson, R. B. (1983). Checklist of Australian Lichens, 1st Edn. National Herbarium of Victoria, Public Lands and Forests Division, Department of Conservation, Forests and Lands, p 70.

Lumbsch, H. T. and Elix, J. A. (1985). A new species of the lichen genus *Diploschistes* from Australia. *Pl. Syst. Evol.*, **150**: 275-279.

Nash, T. H. III & Elix, J. A. (1987). New species and new reports in the Parmeliaceae (Lichenized Ascomycotina) from South Africa and Australia. *Mycotaxon*, **29**: 467-476.

MYCOTAXON

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TAXONOMIC STUDIES IN THE GENUS MYCOSPHAERELLA. 2.
NOTES ON SOME ADDITIONAL SPECIES OCCURRING ON BRASSICACEAE.

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Abstract

Comments, descriptions and illustrations of additional non Canadian species of *Mycosphaerella* occurring on Brassicaceae are provided. Type specimens of four species were examined: *M. denigrans, M. pachyasca, M. pashkiensis and M. pyrenaica*. Several species are only known from their original descriptions as type or other specimens were unavailable for study or not located; some species have never been illustrated.

Introduction

A publication (Corlett, 1988) on the species of *Mycosphaerella* occurring on cultivated, wild and weedy members of the family Brassicaceae in Canada treated four species, *M. brassicicola* (Duby) Lindau, *M. cruciferarum* (Fr.) Lindau, *M. densa* (E. Rostrup) Lind and *M. tassiana* (de Not.) Johans. There are some additional species described from Brassicaceae by various authors which were not dealt with in that publication. I have not seen Canadian collections of these species and they are presently presumed to be extralimital. Some of the names are known to me only from the literature. Type collections of four species have been examined. I have attempted to borrow types of several others for examination but they were unavailable. Nevertheless, it was considered worthwhile to discuss or provide notes or brief descriptions, from personal observations or from the literature, and where possible to provide illustrations. Unfortunately for several species known to me only from the literature and for which types or other collections have not been examined, there are no published illustrations available.

Species described on Brassicaceae

Mycosphaerella alyssi (Holløs) Moesz, Balkan-Kutat. Tud. Eredm. 3: 132 & 136. 1926.

Sphaerella alyssi Holløs, Ann. Hist.-Nat Mus. Hung. 5: 44. 1907.

This species was described by Holløs (op. cit., 1907, p. 44) on *Alyssum tortuosum* Waldst. & Kit. from Hungary. Holløs provided the following description without illustrations: "Peritheciis gregariis, epidermide velatis, depresso-globosis, fuscis, punctiformibus, pertusis, 50-70 μ diam., contextu parenchymatico; ascis ovoideis vel clavatis, breve st[i]pitatis, octosporis, 24-30 x 9-10 μ aparaphysatis; sporidiis 2-3 stichis oblongis, medio 1-septatis, non constrictis, hyalinis, 9-10 x 3-4 μ". Moesz (op. cit., 1926, p. 136), in making the combination to *Mycosphaerella* listed *Alyssum scardicum* Wettst. as a host from Albania. I only know this species from the literature and have not seen type or any other collections, nor have I seen any illustrations of this fungus. *M. alyssi* was described in Tomilin (1979, p. 75). He cited the measurements given by Holløs and did not provide any discussion or illustrations of the asci and ascospores.

Mycosphaerella brassicicola (Duby) Lindau in Engler & Prantl, Die Natürlichen Pflanzenf. 1(1): 424. 1897.

Sphaeria brassicicola Duby in de Candolle, Botanicon Gallicum 2: 712. 1830, as *brassicaecola*, non *Sphaeria brassicicola* Berkeley & Broome in Berkeley, Outlines Brit. Fung., p. 401. 1860.

Sphaerella brassicicola (Duby) Cesati & de Notaris, Comment. Soc. Crittog. Ital. 1(3): 238. 1963.

Anamorph: *Asteromella brassicae* (F. Chevallier) Boerema & van Kesteren, Persoonia 3: 18. 1964.

This important pathogen causing conspicuous "ring spot" lesions on the leaves of *Brassica* species has been redescribed, illustrated and discussed by Punithalingam and Holliday (1975) and by Corlett (1988, p. 63).

Mycosphaerella carniolica (Niessl) Lindau, Hilfsb. Sammeln Ascomyceten, p. 38. 1903.
Sphaerella carniolica Niessl, Oesterr. Bot. Z. 25(3): 85. 1875; Hedwigia 14(10): 147. 1875.

Sphaerella carniolica originally was described by Niessl (op. cit., 1875) from *Draba ciliata* Scop. without illustrations as follows: "Epirarius hypophylla. Perithecia dense disseminata, minuta, punctiformia, globosa, papillata, tandem vertice umbilicata, atra; ascis fasciculatis 8sporis, obovatis vel oblongis, sessilibus 30-42 x 14-18; sporidiis farctis, cuneato-oblongis, rectis, medio septatis vix constrictis, dilute virescentibus 15-19 x 4-5".

This name is known to me only from the literature; I have not seen the type or any other collections. Tomilin (1979, p. 76) accepted *carniolica* as a distinct species of *Mycosphaerella* but provided no illustrations. Lind (1934, p. 66) considered *Sphaerella carniolica* to be a synonym of *Mycosphaerella confinis* (Karsten) Dearness (as *confinis* (Karsten) Lind). Von Arx (1949, p. 40) considered both *confinis* and *carniolica* to be synonyms of ***Mycosphaerella tassiana*** (de Notaris) Johanson. Niessl's measurements for the asci and ascospores of *S. carniolica* are rather low for a mature specimen of *M. tassiana*. I am unable to comment on the taxonomic status of this species.

Mycosphaerella confinis (P.A. Karsten) Dearness, Rep. Can. Arctic Exped. 1913-1918 4(C): 6. 1923.
Sphaerella confinis P.A. Karsten, Ofvers. Forh. Kongl. Svenska Vetensk.-Akad. 1872(2): 106. 1872; Hedwigia 11: 187. 1872.

This species was described by Karsten (op. cit., 1872) from dead foliage of *Braya purpurascens* Bunge, *Draba martinsiana* Gay and *D. wahlenbergii* Hartm. from Svalbard, Norway without illustrations as follows: "Perithecia dense gregaria, amphigena, primitus epidermidi innata, dein protuberantia, sphaeroidea, interdum vertice obtusissime conoidea, dein ostiolo rotundato hiantia, laevia, glabra, nigra, latit. circiter 150 mmm. Asci subsessiles, fusoideo-elongati vel elongato-clavati, vulgo inaequilaterales, longit. 50-65 mmm., crassit. 11-13 mmm. Sporae 8:nae, di- vel subtristichae, aciculari- vel fusoideo-elongatae, ut plurimum leviter curvulae, uniseptatae, medio non constrictae, hyalinae, longit. 16-24 mmm., crassit. 3-5 mmm. Paraphyses nullae". Measurements given by Saccardo (Syll. F. 1: 507-8. 1882) for *S. confinis* Karsten differ somewhat from those given by Karsten and are as follows: perithecia 100-120μm, asci 45-52 x 10-13μm, ascospores 14-19 x 3-5μm. Dearness (op. cit., 1923, p. 6) listed a collection on *Anemone parviflora* Michx. [Ranunculaceae]. A collection identified as *M. confinis* in the Dearness herbarium (no. 6018) in DAOM, is on *Antennaria margaritacea* R. Br. [Asteraceae]. Number 6018 does not agree with Karsten's description of *S. confinis*; the asci of the Dearness specimen are cylindrical and narrow and measure 45-50 x 6-9μm and the ascospores at 14 to 15μm in length likewise do not match Karsten's description.

Von Arx (1949, p. 40) considered *Sphaerella confinis* Karsten to be a synonym of ***Mycosphaerella tassiana*** (de Notaris) Johanson.

Mycosphaerella cruciferarum (Fries) Lindau in Engler & Prantl, Die Naturlichen Pflanzenf. 1(1): 324. June 1897.
Sphaeria cruciferarum Fries, Systema Mycol. 2: 525. 1823.
Sphaerella cruciferarum (Fries) Saccardo, Michelia 2: 315. 1881.

A presumably authentic collection of *Sphaeria cruciferarum* Fr. from the Fries herbarium at UPS on *Cheiranthus* L. from France was seen by me. A microscope slide prepared from this collection possessed a single fascicle of relatively mature aparaphysate asci, 60-65 x 14-16μm, unfortunately without ascospores. While these asci have the morphology and dimensions of asci of *M. cruciferarum* (Corlett, 1988), a positive identification cannot be made. *M. cruciferarum* was recently redescribed and illustrated by Corlett (1988, p. 64). Despite not having observed type or good authentic material, this species appears to be well characterized (Barr, 1959, p. 15; Corlett, op. cit.) by its relatively broad fusoid ascospores and the presence of a network of dark subepidermal hyphae connecting individual closely grouped ascomata.

Mycosphaerella denigrans (Kirschstein) Tomilin, Opredelitel'gribov roda *Mycosphaerella* Johns., p. 77. 1979.
Sphaerella denigrans Kirschstein, Ann. Mycol. 37: 103. 1939.
Mycosphaerella phlomidicola Tomilin, Nov. · Sist. Niz. Rast. 1966, p. 150. 1966. FIG. 1

Sphaerella denigrans was described by Kirschstein (op. cit., 1939, p. 103) from *Erysimum hieraciifolium* [given without authority] without illustrations and described as follows: "Peritheciis dense stipatis, substratum denigratum saepe longe, interdum ex toto inducentibus, sub peridermio convexo-sublato orientibus, demum plus minus erumpentibus, ostiolo plano, pertuso, rotundulo instructis, nigris, globosis, membranaceis, 80-100 μ diam.; contextu fuliginoso, e cellulis minutis composito. Ascis aparaphysatis, late cylindraceis vel clavatis, apice plane rotundatis et incrassatis, vix pedicellatis, 8-sporis, 25-30 x 7-9 μ. Sporidiis oblique monostichis vel longitudinaliter di- vel tristichis, hyalinis, medio uniseptatis, oblonge ellipsoideis, rectis et [subinaequalibus], non constrictis 10-11 x 3 μ". Tomilin (op. cit., 1979, p. 77 & fig. 39) has examined the holotype collection of *Sphaerella denigrans*, ex herb B, and has redescribed

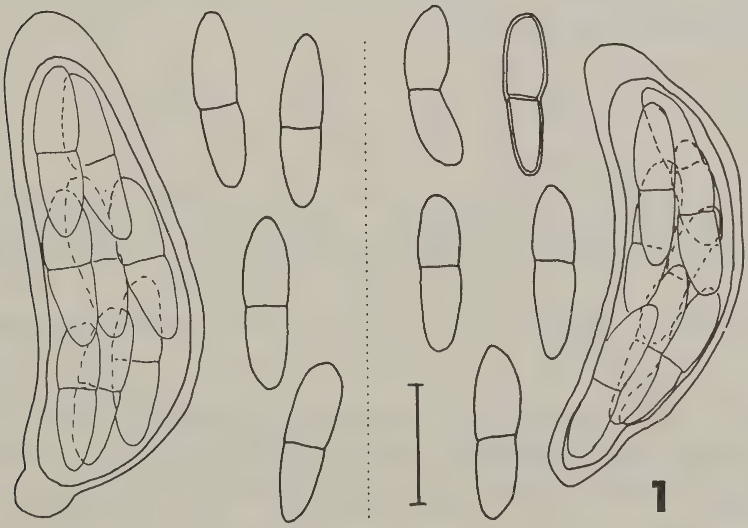

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FIGURE 1, asci and ascospores of *Mycosphaerella denigrans* ex type: left side, redrawn from Tomilin (1979, fig 39). (scale = 10um) and illustrated this species. The dimensions given by Tomilin for *M. denigrans* are as follows: ascomata 80-100μm diam.; asci 30-34 x 10-11μm; ascospores 10-12 x 2.5-3μm. I likewise have examined the holotype of *Sphaerella denigrans* and found asci and ascospores which agree with Kirschstein's description and match the dimensions and illustrations provided by Tomilin for this species. My measurements for the asci and ascospores were 30-37 x 9-11μm and 12-14 x 3-3.5μm respectively. The ascomata were subepidermal, medium brown in colour and 99-110μm wide. The beak was 30-40μm across and the ostiole ca 10μm. *M. denigrans* is very similar to the earlier published *M. pyrenaica* (Speg.) Arx. The dimensions and morphology of the ascospores of the two species are very close.

Mycosphaerella densa (E. Rostrup) Lind, Rep. Sci. Results Norw. Exped. Novaya Zemlya 1921, 19: 12. 1924.
S. densa E. Rostrup, Bot. Tidsskr. 14(3): 225. 1885.

This species was redescribed and illustrated by Corlett (1988, p. 65). The description provided was based in part on observations of the type collection, ex herb. C.

Mycosphaerella hambergii (Romell & Saccardo) Petrak, Acta Horti Gothob. 17: 137. 1947.
Sphaerella confinis P.A. Karsten, Ofvers Forh. Kongl. Svenska Vetensk.-Akad. 1872(2): 106. 1872 subspecies *hambergii* L. Romell & Saccardo in Saccardo, Syll. Fung. 11: 296. 1895

Romell and Saccardo (op. cit., 1895, p. 296) described *Sphaerella confinis* var. *hambergii* on *Arabis gerardi* Bess. from Sweden without illustrations as follows: "Peritheciis dense gregariis, subsphaeroideis, 100 μ diam., epidermide arcte velatis erumpentibusque, nigris, subastomis; ascis subclavatis sessilibus, 25-50 x 7-10; sporidiis oblongo-fusoideis, obscure uniseptatis, plerumque 4-guttatis, rectis curvulisve, 12-15 x3-4, ex hyalino chlorinis". The dimensions given for subspecies *hambergii* are slightly less than those given by Karsten (op. cit., 1872) for *Sphaerella confinis* Karsten (= *M. tassiana* (de Notaris) Johans.). Tomilin (1979) did not discuss *M. hambergii*. I have not seen any material of this species and am unable to comment on its taxonomic status.

Mycosphaerella isatidis Kalymbetov, Trudy Inst. Bot.7: 326. 1959.

M. isatidis was described by Kalymbetov (op. cit., 1959, p. 326) on *Isatis tinctoria* L. from Kazakhstan. Kalymbetov provided the following description without illustrations: "Perithecia globosa, nigra, primo, immersa, dein emergentia. Asci cylindrici, basi fasciculati, hyalini, aparaphysati, 12,3-21,5 x 34,4-51,6 *μ*. Sporae hyalinae, bicellulares, cylindricae, 8,6-12,3 x 4,3-6,4 *μ*". Tomilin (1979, p. 291) provided a brief description of Kalymbetov's species without illustrations: ascomata 70-100*μ*m; asci 34-52 x 12-21*μ*m; ascospores 10-13 x 4-5(6)*μ*m; host *Isatis tinctoria* L. This species is known to me only from the literature. I have not seen type or any other material of *M. isatidis* and am unable to comment on its taxonomic status.

Sphaerella napicola Fautrey, Rev. Mycol. 12(46):64. April 1890.

S. napicola was described by Fautrey (op. cit., 1890, p. 64) on dead stems of *Brassica napus* L. [var. *oleifera*?]. Fautrey provided the following description without illustrations: "Taches grandes indéterminées noires; Périthèces nombreux, pressés sur la tache et disséminés au dehors, arrondis, noirs; Thèques ventrues; Spores hyalines, uniseptées, à 4 gouttes, à loge supérieure plus longue et plus large, 18, 28 x 4, 6 [18.28 x 4.6]".

Tomilin (1979, p. 77) listed *S. napicola* as a synonym of **Mycosphaerella cruciferarum** (Fries) Lindau. Certainly, the ascospore measurements given by Fautrey are within the range of those of *M. cruciferarum*. I have not seen the type or any other collections of this species.

Mycosphaerella pachyasca (E. Rostrup) Vestergren, Bih. Kongl.
Svenska Veten.-Akad. Handl. 26(3, 12): 7. 1900.
Sphaerella pachyasca E. Rostrup, Meddl. Groenland 3(2): 552. 1888.
FIG. 2

Rostrup (op. cit., p. 552-3) stated that *Sphaerella pachyasca* Rostrup was common and widespread, occurring on dicotyledonous members of numerous plant families in Greenland, including *Draba* and *Arabis*, members of the Brassicaceae. He considered it to be the morphological equivalent of *Sphaerella tassiana* de Notaris, the latter being restricted to monocot hosts by Rostrup. Further, Rostrup stated that these two species or species complexes were probably converging and in many cases could only be distinguished on the basis of whether the host was a dicot or a monocot [English translation of Rostrup's discussion provided by Dr. H. Knudsen, Keeper of Mycology at the Botanical Museum (C)]. Rostrup described *S. pachyasca* without illustrations as follows: "Perithecia sparsa v. gregaria, foliicola v. cladogena. Asci crasse ovoideo-oblongati, inaequilaterales, long. 40-50 μ, crass. 15-24 μ, vulgo apice tunicati. Sporae conglobatae, conoideo- v. ovoideo-oblongatae, long. 16-20 μ, crass. 5-6 μ.

Von Arx (1949, p. 40) considered this species to be a synonym of ***Mycosphaerella tassiana*** (de Notaris) Johanson. I have

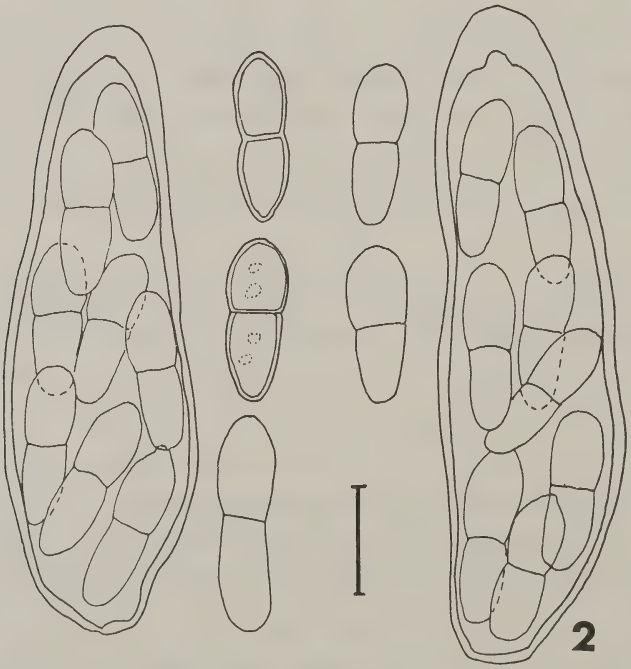

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FIGURE 2, asci and ascospores of *Mycosphaerella pachyasca* from one of several collections labelled "Typus", Disco I., 20-7-84[1884]. (scale = 10um) examined collections of *S. pachyasca* cited by Rostrup (op. cit., p. 552) ex Herb. C and all labelled as "TYPUS". I found asci and ascospores representative of *S. pachyasca* in only a few of these; the asci and ascospores measured 56-60 x 17-17.5um and 15-20 x 5-6.2μm respectively. These collections are morphologically indistinguishable from material I consider to be representative of *M. tassiana* (Corlett, 1988). I agree with the use of *M. tassiana* sensu von Arx as a single broad unspecialized species or species complex perhaps, widespread on many monocot and dicot plant families. If *M. pachyasca* were to be maintained as a distinct species, a lectotype would have to be selected from among the collections listed by Rostrup with his description of *S. pachyasca*.

Collections examined and yielding ascospores: On *Plantago borealis*, Itivnek, W. & H., 13-7-84. On *Diapensia lapponica*, Disco I., W. & H., 20-7-84. On *Draba hirta*, Upernivik, 8-84.

Mycosphaerella pashkiensis Petrak, Sydowia 16(1-6): 340. 1962 [May 1963]. FIG. 3

M. pashkiensis was described by Petrak (op. cit., p. 340) on dead leaves of *Draba* species from Afghanistan. Petrak provided the following description without illustrations: "Perithecia amphigena sed plerumque hypophylla, per totam folii superficiem irregulariter dispersa, solitaria, raro bina complurave subaggregata, subepidermalia, depresso-globosa vel late ellipsoidea, 70-100 μ diam., raro etiam paulo majora, omnino clausa, nec ostiolata; pariete membranaceo, ca. 10 μ crasso, contextu pseudoparenchymatico e cellulis irregulariter angulosis vel fere globosis, vix compressis, obscure atro-brunneis, 3,5-6 μ diam. metientibus composito; asci sat numerosi, rosulati, cylindracei, antice late rotundati, postice plus minusve sed plerumque parvum saccati, subsessiles vel brevissime et crassiuscule noduloso-stipitati, 8-spori, 42-55 x 9-10,5 μ; sporae di-vel indistincte tristichae, clavato-cylindraceae vel bacillari-clavatae, utrinque obtusae, antice vix vel parum., postice plerumque distincte et paulatim attenuatae, rectae, raro inaequilaterae, circa medium septate nec constrictae, guttulis plerumque duabus in quaque cellula praeditae, hyalinae, 10-13 μ, raro usque ad 14,5 μ longae, 2,5-3,5 μ latae; paraphysoides paucae, indistincte fibrosae, mox omnino mucosae". *Mycosphaerella pashkiensis* Petrak was accepted by Tomilin (1979, p. 76) who published a brief description without illustrations: ascomata 70-100μm; asci 42-55 x 9-10.5μm; ascospores (10)12-14 x 2.5-3(3.5)μm; host *Draba*.

I have examined the type collection of *M. pashkiensis* ex herb. W. My dimensions of the asci (specifically ascus width) and ascospores from the type collection exceed the measurements given by Petrak for *M. pashkiensis*. My description of the type material is as follows: ascomata subepidermal, medium brown, 78-108μm diam., ostiole, pale brown, ca 10μm diam. Asci bitunicate, thick-walled, saccate when young, clavate to somewhat cylindrical, widest above or below, 8-spored, 42.5-51 x 12.5-14μm [Petrak: 42-55 x 9-10.5].
Ascospores hyaline, mostly cylindrical-clavate, straight or curved, 15-18.5 x 4-5.25μm [Petrak: 10-13(14.5) x 2.5-3.5], septate at or near the middle, not or hardly constricted at the septum, upper cell wider and ascospores distinctly tapering to the base, ends rounded but not broadly so, bi- to triseriate in the ascus. I believe that both Petrak and I observed the same fungus but I cannot account for the discrepancy in our dimensions of the asci and ascospores. My measurements approach those of a small or immature *Mycosphaerella tassiana*.

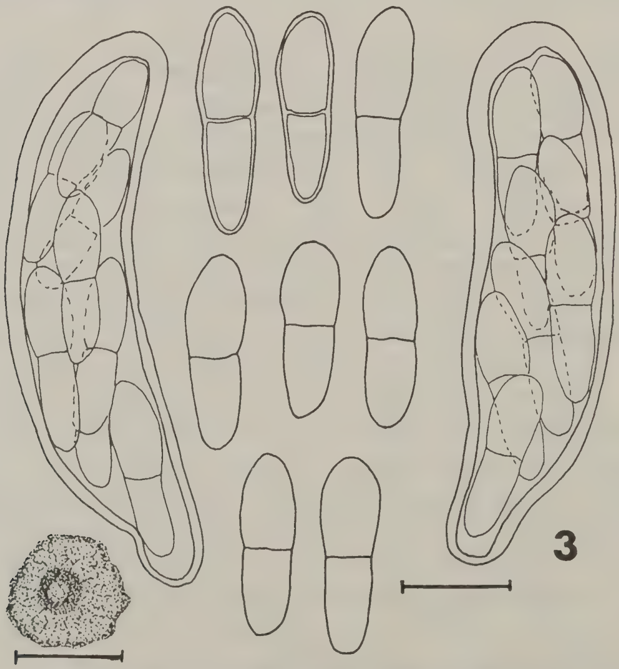

FIGURE 3, ascoma, asci and ascospores of *Mycosphaerella pashkiensis* ex type. (scales = 100um & 10um respectively)

Mycosphaerella pyrenaica (Speg.) Arx, Sydowia 3:64. 1959.
Sphaerella pyrenaica Speg., Rev. Mycol. 4(14): 78. 1882.
FIG. 4

Spegazzini (op. cit. 1882, p. 78) described *S. pyrenaica* from dead tissue of *Peterocallis* [*Draba]*] *pyrenaica* from France. He provided the following description without illustrations: "Perithecia amphigena, globoso-lenticularia (90-100), innato-erumpentia, atra, submembranacea, contextu parenchymatico, fuligineo; asci cylindraceo-clavati, breve stipitati (40-45 x 8), apice crassiuscule tunicati, octospori, aparaphysati; sporidia disticha, cylindraceo-elliptica, utrinque obtusiuscule rotundata (15 x 3), medio 1-pseudoseptata, non constricta, hyalina". The dimensions given by von Arx (op. cit., p. 64) generally agreed with those of Spegazzini: "Pseudothecien ... 90-130 μ... Asci ... 40-50 x 9-11 μ... Sporen ...14-19 x 3-4 μ ..". *M. pyrenaica* was accepted by Tomilin (1979, p. 77) who listed *Cardamine bellidifolia* L., *Cochlearia officinalis* L., *Parrya nudicaulis* (L.) Regel and *Petrocallis* [*Draba*] *pyrenaica* as hosts.

I have examined the type collection of *S. pyrenaica* Speg., ex herb. LP and concur with the description and dimensions provided by Spegazzini and by von Arx. My observations of type material are as follows: ascomata subepidermal, 85-100μm diam, medium brown; asci cylindrical-clavate, 8-spored, 40-48 x 9.5-12μm; ascospores hyaline, cylindrical-ellipsoidal, straight or curved, 14.5-18.5 x 3.5-4.5μm, septate at or just below the middle, not or hardly constricted at the septum, upper cell sometimes slightly wider than lower cell, ends rounded, bi- to triseriate in the ascus.

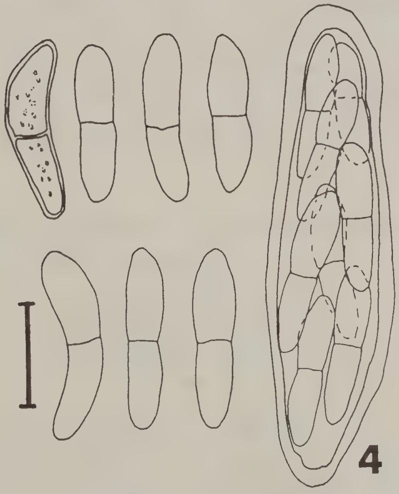

FIGURE 4, ascus and ascospores of *Mycosphaerella pyrenaica* ex type (scale = 10um)

Mycosphaerella tassiana (de Notaris) Johanson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 41(9): 167. 1884.

Sphaerella tassiana de Notaris, Sferiacei Italici 1(1): 87. 1863.

Anamorph: *Cladosporium herbarum* (Pers.) Link: S.F. Gray, Nat. Arr. Brit. Pl. 1:556. 1821.

A very common and distinctive species found on numerous host plants in different monocot and dicot families. Lind (1934, p. 60) listed 110 species, a few non-angiosperms but mostly monocots and dicots, as hosts of *M. tassiana*. This species has been described and illustrated by von Arx (1949, pp. 40-59), M.E. Barr (1959, p. 23-27; 1972, p. 603), Sivanesan (1984, p. 225) and Corlett (1988, p. 67-72). An extensive list of *tassiana* synonyms, including *M. allicina* (Fr.: Fr.) Vestergren and *M. pachyasca* (E. Rostrup) Vestergren (see above) and a lengthy host list were provided by von Arx (op. cit.) while de Vries (1952) listed the synonyms of the anamorph. Tomilin (1979, p. 270) also considered *tassiana* and *allicina* to be synonyms but unlike von Arx, listed *M. tassiana* as a synonym of the earlier published *M. allicina* (basionym: *Sphaeria allicina* Fr.: Fr., Kongl. Vet.-Akad. Handl. 38:247. 1817). M.E. Barr (1972, p. 600) maintained the morphologically similar *M. allicina* as distinct, considering it to be specialized and host restricted, parasitic on species of *Allium* in contrast to the wide unspecialized host range of *M. tassiana*.

Mycosphaerella vesicariae-arcticae (Hennings) Tomilin, Opredelitle'gribov roda *Mycosphaerella* Johans., p. 78. 1979.

Sphaerella vesicariae-arcticae P. Hennings in Allescher & Hennings, Biblioth. Bot. 42: 45. 1897.

This species was described by Hennings (op. cit. 1897, p. 45) on leaves and stems of *Vesicaria arctica* R. Br. [this authority differs from those of the various homonyms of *Vesicaria arctica* given in Index Kewensis] var. *lejocarpa* Trautw. from Denmark. Hennings provided the following description without illustrations: "Peritheciis caulicolis et amphigenis .sparsis gregariisve, subglobosis atris; ascis oblongis subclavatis vel subfusoideis 60-75 x 17-21 μ, apice obtusis, 8-sporis; sporidiis subdistichis vel conglobatis, clavatis utrinque obtusis, medio 1 septatis haud constrictis, rectis, hyalinis 20-25 x 7-8 μ". Tomilin (op. cit., 1979, p.78) transferred Hennings's species to *Mycosphaerella* and provided a description without illustrations:

ascomata 90-120μm; asci 60-65 x 20-24μm; ascospores 17-19 x (5.5)6-7μm. Tomilin listed *Vesicaria* and *Parrya nudicaulis* (L.) Regel. as hosts. I have not seen the type or any other specimens of *vesicariae-arcticae* although the descriptions provided by both Hennings and Tomilin suggest a small spored *Mycosphaerella tassiana*.

Dimensions of ascomata, asci and ascospores of species of *Mycosphaerella* on Brassicaceae taken from original authors or from Corlett[c] (1988)

Name	Ascomata diameter	Asci	Ascospores
alysii	50-70	24-30x9-10	9-10x3-4
brassicicola[c]	90-145	30-47(55)x12-16	16-25x3-4
carniolica		30-42x14-18	15-19x4-5
confinis[*]	150	50-65x11-13	16-24x3-5
cruciferarum[c]	84-125	34-55x9-16	13-15x3.5-5
denigrans	80-100	30-37x9-11	12-14x3-3.5
densa[c]	85-140	36-54x9-11	14-24x3-4.5
hambergii	100	25-50x7-10	12-15x3-4
isatidis		34-51x12-21	8.5-12x4-6
napicola[**]			18.28x4.6
pachyasca[*]		40-60x15-24	16-20x5-6.5
pashkiensis[c]	78-108	42-51x(9)12-14	[10-13x2-3.5] 15-18x4-5
pyrenaica	85-100	40-48(50)x9-12	14-19x3-4.5
tassiana[c]	75-155	45-88x15-29(32)	17-31x4.5-9.5
vesicariae-arcticae	90-120	60-75x17-24	17-25x6-8

[*] = *tassiana*
[**] = *cruciferarum*

Host Index
Species of *Mycosphaerella* on genera of Brassicaceae

Alyssum
- *alyssi*TH

Arabis
- *hambergii*
- *tassiana*

Brassica
- *brassicicola*
- *cruciferarum*
- *napicola*
- (= *cruciferarum*)

Braya
- *confinis*TH
- (= *tassiana*)
- *densa*
- *tassiana*

Cardamine
- *densa*
- *pachyasca*
- (= *tassiana*)
- *pyrenaica*
- *tassiana*

Cheiranthus
- *cruciferarum*

Cochlearia
- *densa*
- *pyrenaica*
- *tassiana*

Draba
- *carniolica*
- *confinis*
- (= *tassiana*)
- *cruciferarum*
- *densa*
- *pachyasca*
- (= *tassiana*)
- *pashkiensis*TH
- *tassiana*

Erysimum
- *cruciferarum*
- *denigrans*TH

Eutrema
- *cruciferarum*
- *tassiana*

Isatis
- *isatidis*TH

Lesquerella
- *tassiana*

Parrya
- *pyrenaica*
- *tassiana*
- *vesicariae-arcticae*

Petrocallis (=Draba)
- *pyrenaica*TH

Vesicaria
- *vesicariae-arcticae*TH

TH = Type Host

Acknowledgements

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References

Arx, J.A. von. 1949. Beiträge zur Kenntnis der Gattung *Mycosphaerella*. Sydowia 3: 28-100.

Barr, M.E. 1959. Northern Pyrenomycetes I. Canadian Eastern Arctic. Contr. Inst. Bot. Univ. Montréal 73:1-101.

Barr, M.E. 1972. Preliminary studies on the Dothideales in temperate North America. Contr. Univ. Mich. Herb. 9(8): 523-638.

Corlett, M. 1988. Taxonomic studies in the genus *Mycosphaerella*. Some species of *Mycosphaerella* on Brassicaceae in Canada. Mycotaxon 31(1): 59-78.

De Vries, G.A. 1952. Contribution to the knowledge of the genus *Cladosporium* Link ex Fr., 121 pp., Diss. Univ. Utrecht, Baarn.

Lind, J. 1934. Studies on the geographical distribution of arctic circumpolar micromycetes. Kongel Danske Videnskabernes Selskab. Biol. Meddel. XI, 2 pp. 54-72.

Punithalingam, E. & P. Holliday. 1975. CMI Descript. Path. Fungi & Bacteria No. 468. *Mycosphaerella brassicicola*. CAB Intern. Mycol. Inst., Kew, Surrey.

Sivanesan, A. 1984. The bitunicate Ascomycetes and their anamorphs. J. Cramer, Vaduz, pp. 1-701.

Tomilin, B.A. 1979. Opredelitel'gribov roda *Mycosphaerella* Johans., Nauka, Leningrad, pp. 319.

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DEVELOPMENT OF CONIDIOMATA IN THE *PHYLLOSTICTA* STATE OF *GUIGNARDIA MANGIFERAE* ROY AND OBSERVATIONS ON THE FINE STRUCTURE OF THE CONIDIUM

by
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SUMMARY

The development of conidiomata in the *Phyllosticta* state of *Guignardia mangiferae* Roy on the host and in culture is described. Fine structural details of the sheath around the conidium is provided.

INTRODUCTION

The developmental stages of the conidiomata in Coelomycetes have only been studied in detail in a few members of this group (Punithalingam 1966;1981;1982; Maas et al., 1979; Muthumary and Vanaja 1986). In this investigation developmental stages of the conidiomata in the *Phyllosticta* state of *Guignardia mangiferae* Roy were investigated. This forms part of a programme of work on developmental morphology and taxonomy of coelomycetes which is in progress in this department. An attempt was also made to provide information regarding the fine structure of the conidium.

MATERIALS AND METHODS

The material used in this study was collected in Vandaloor, near Madras, growing on leaves of *Mangifera indica* in September, 1991. The fungus was isolated in pure culture on oatmeal agar. The specimen was processed for TEM studies with a view to obtaining information on the ultrastructural details of the conidium and its appendage in relation to the wall layers. Portions of agar with conidiomata were fixed in primary fixative ie. 5.0% Glutaraldehyde (W/V) in 0.1 M phosphate buffer (pH=7.5) for 30 min. at room temperature and for 1 hr,. at 4°C. Similarly pieces of leaf with conidiomata were also processed in the same manner. Three washes were given in the buffer solution at 4°C to remove traces of the GA, before fixing in 1.0% O_sO_4 for 1 hr at 4°C. After washing several times in phosphate buffer the specimen was dehydrated through a graded series of Acetone. Subsequently the specimen was embedded in Araldite (Araldite My

753=10ml, DDSA=10 ml, BDMA = 0.4 ml, N.Dibutylphthalate =0.5ml) and polymerized at 60°C for 36 hrs. Gold colour sections were cut with an ultracut ultramicrotome. Semithin sections of about 0.1 µ thickness were selected to follow the different stages of development of the conidiomata. The semithin sections were stained with aqueous Toluidine blue for light microscopic observations. Ultrathin sections were collected on copper grids and stained with Uranyl acetate followed by lead citrate (Reynolds, 1963). Sections were observed with a CM 10 Philips Electron Microscope at 40 Kv.

RESULTS

Formation of conidiomatal primordium. The earliest stage of pycnidial development seen in sectioned material from the culture consists of a small, pseudoparenchymatous mass of tissue, the pycnidial primordium (Fig. 1). The pycnidial primordium is almost spherical, consisting of a compact cluster of brown, thick -walled cells. During further development, the primordium considerably increases in size by continued transverse and longitudinal divisions of the cells.

Formation of the pycnidial cavity. As a prerequisite for the formation of the pycnidial cavity, the cells at the periphery and centre of the primordium were arranged as follows. The cells along the outer layers of the primordium became arranged tangentially which subsequently formed the conidiomatal wall (Figs. 2-4). The inner cells of the primordium were thin-walled and hyaline whereas the peripheral cells were brown and thick - walled. There may be more than one method involved in the formation of the central cavity. The presence of ruptured and disorganised cells in the cavity indicates that the cavity might have formed by the rupture of cells at the centre of the primordium (Figs. 5-6). The occurrence of hyphal fragments and a gelatinous material within the cavity suggest that the cells are later dissolved to form the cavity (Fig.3). From the many sections examined, both these conditions were observed as being present in the fungus. The tangentially arranged outer layers of cells form the pycnidial wall by repeated division, thereby increasing the dimension of the developing conidioma. Simultaneously, the outer wall layers become carbonaceous and at maturity the wall consists of 5-6 tangentically arranged layers, the cells of the inner layers being hyaline and thin-walled (Figs. 10-11).

Formation of sporogenous tissue. In conidiomata formed in culture, the formation of conidia from the conidiogenous cells resembles that of *Ascochyta* spp.. (Punithalingam, 1979) and *Macrophomina phaseolina* (Tassi) Goid. (Punithalingam, 1982). After the cavity is formed by dissolution and disintegration of central cells of the primordium, the cells lining the cavity commence conidial production by a budding like process. Eventually these conidiogenous cells, along with conidia become detached from the wall of the conidioma (Figs. 5- 8), and remain floating still intact in the conidiomatal cavity (Figs 7-8). The conidiogenous cells which were produced initially inside the cavity are referred to as "temporary conidiogenous cells" by Punithalingam (1979). These temporary conidiogenous cells very occasionally bear an annellation and were normally blastic. Subsequently the cells lining the cavity elongate to form a palisade of permanent conidiogenous cells (Punithalingam, 1979) which then start producing conidia (Fig. 9).

The presence of permanent conidiogenous cells were observed even when the cavity filled up with dissolved and disintegrated primordial cells (Fig. 9). Consequently the conidioma becomes considerably larger in size by proliferation of the outer layers of the pseudoparenchyma while the inner cells become arranged tangentially into several layers (Figs. 10-12).

Formation of ostiole. When the conidioma becomes fully mature, a papilla-like projection appears at the apex (Figs. 16-18). In vertical section, the papilla shows thick-walled, dark cells towards the outer side and thin walled, hyaline, elongated cells towards the inner side (Figs. 13-15). During dehiscence of the conidioma, these inner hyaline layers in the papilla dissolve to form the ostiole and the outer, thick walled cells of the papilla remain intact and form the papillate structure of the conidioma. The papilla may also exert pressure to rupture the epidermis of the host for releasing the conidia outside.

Fine structure of the conidia. Light microscopic studies by Punithalingam (1982) showed that the conidium is enveloped by a thick sheath which remains intact, its outer most layer gradually gelatinizing with the ageing of the conidium, and our studies using TEM confirmed the presence of this thick sheath around young conidia. Our observations showed the presence of the sheath around the conidiogenous cells and the growing conidium (Fig. 20). Transverse sections of a young conidium also revealed the presence of the sheath (Figs. 22-23 & 25), but in TEM micrographs of old conidia the sheath around the conidia was absent (Figs. 19, 21 & 24). It is therefore probable that during the later stage of development, the sheath around the conidium gradually gelatinizes. In observations with the light microscope, conidia within young pycnidia were found with the sheath surrounding them (Fig. 14). The mature conidium is multinucleate (Punithalingam and Woodhams, 1982) and in this study, at least three nuclei were observed (Fig. 21). TEM studies showed that the sheath surrounding the conidium disappears with ageing (Figs. 19, 21).

DISCUSSION

The origin and structure of the apical conidial appendage of *Phyllosticta* spp. had already been fully described by Punithalingam and Woodhams (1982). The cultural characters of the *Phyllosticta* state of *Guignardia mangiferae* Roy along with the connection between the ascogenous state has also been thoroughly investigated (Punithalingam 1974). This work deals with the different stages of development of the conidiomata within the natural host and also in artificial culture media. It was observed that the *Phyllosticta* sp. investigated here produces temporary and permanent conidiogenous cells similar to those of *Ascochyta* spp. (Punithalingam 1979) and *Macrophomina phaseolina* (Punithalingam, 1982). Normally the temporary conidiogenous cells produce a single conidium after which they get sloughed off from the wall layers. In the present fungus, the temporary conidiogenous cells occasionally show one annellation indicating that it is capable of producing more than one conidium. Probably after producing one or two conidia, the temporary conidiogenous cells may become detached from the wall layers.

Another interesting finding is the presence of the thick sheath around the conidium. This sheath was also observed covering the conidiogenous cell and the conidium initial. The presence of the sheath around the conidium confirms observations made by light microscopy. Both transverse and longitudinal sections of the old conidia failed to reveal a sheath surrounding the conidia suggesting that the sheath gradually gelatinizes and disappears as the conidium becomes old.

The dual conidiation process was found as a general feature of *Ascochyta* species in culture (Punithalingam 1979) and also in *Macrophomina phaseolina* (Punithalingam 1982). Other Coelomycete species studied by the authers, namely, *Botryodiplodia theobromae* Pat., *Ciliochorella mangiferae* Syd., *Coleophoma cylindrospora* (Desm.) Höhn., *Pestalotiopsis palmarum* (Cooke) Stey. and *Urohendersonia pongamia* Naj Raj & Ponnappa also show this type of dual conidiation process in culture. In the present investigation the *Phyllosticta* species also was found to produce temporary and permanent conidiogenous cells. But *Robillarda depazeoides* (Welw. et Curr.) Sacc. was found to produce only one type of conidiogenous cells during conidiation in culture. Therefore the present study reveals that necessary data collected based on the developmental morphology of conidiomata for many more Coelomycetes will be useful for segregating genera into differant groups. In addition, the ultrastructural details of the conidia given in the present investigation have provided useful information regarding the biological significance of the mucilaginous sheath around the conidium.

REFERENCES

Maas, J.L., Pollack, F.G. and Uecker, F.A. 1979. Morphology and development of *Pilidiella quercicola. Mycologia 71*: 92-102.

Muthumary, J. and Vanaja,R. 1986. Development of conidiomata in *Coniella fragariae. Trans. Br. Mycol. Soc.* 87(1): 109-114.

Punithalingam, E. 1966. Development of the pycnidium in *Septoria. Trans. Br. Mycol. Soc. 49*: 19-25.

---------, 1974. Studies on Sphaeropsidales in culture II. Mycol. Pap. 136: 1-63.

---------, 1979. Graminicolous *Ascochyta* Species. Mycol. Pap. 142: 1-214.

---------, 1981. Conidiation and appendage formation in *Tiarosporella paludosa (Sacc. & Fiori) Hohnel. Nova Hedwigia 34*: 539-567.

---------, 1982. Conidiation and Appendage formation in *Macrophomina phaseolina* (Tassi) Goid. *Nova Hedwigia 36*: 249-290.

--------- and Woodhams, J.E. 1982. The conidial appendage in *Phyllosticta* spp. *Nova Hedwigia 36*: 151-198.

Reynolds, E.S. 1963. The use of lead citrate at high pH as an electron opaque stain in electron microscopy. *Journal of cell Biology. 17*: 208-212.

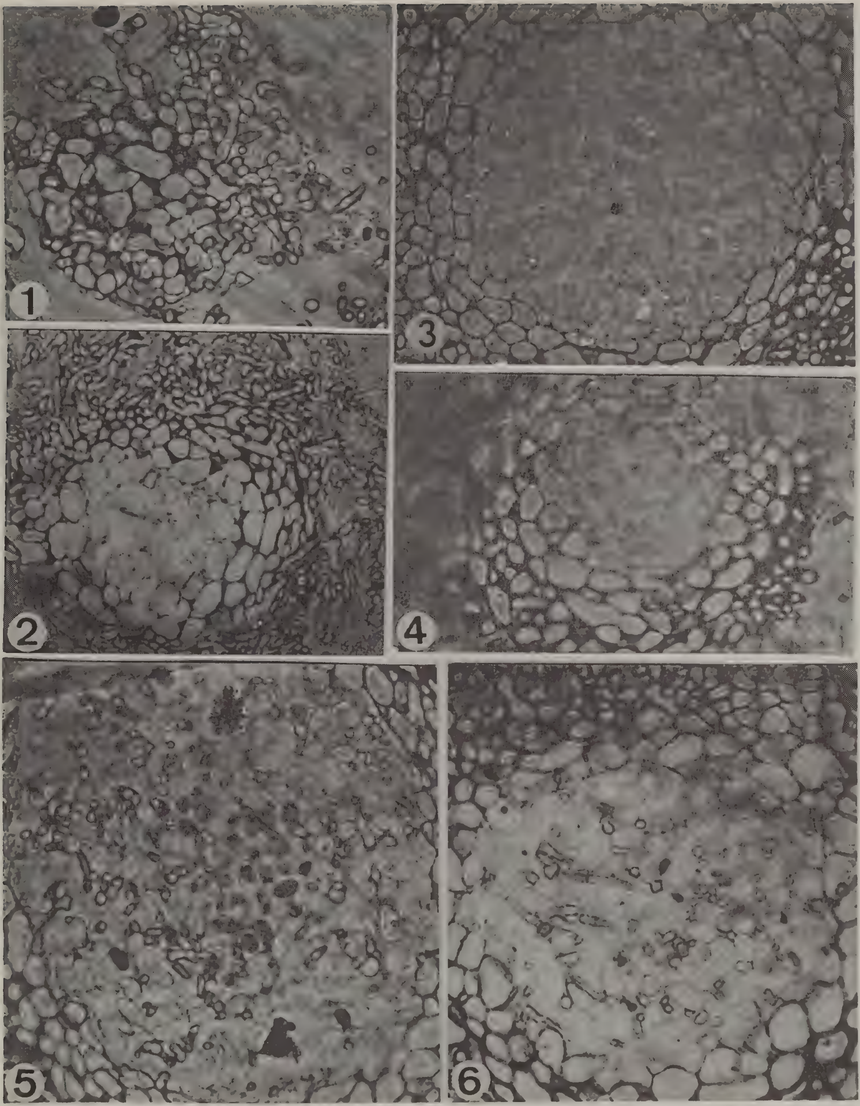
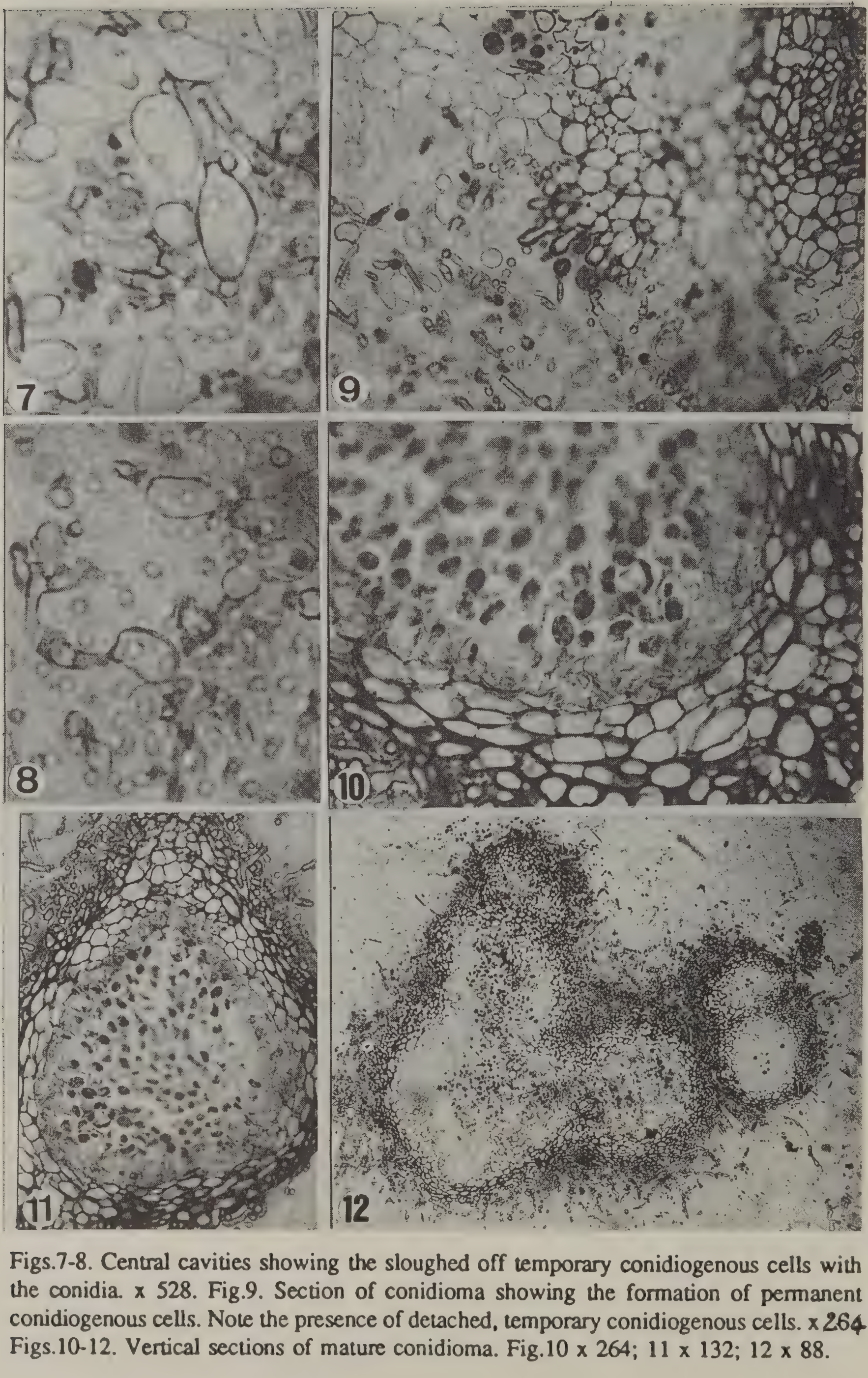
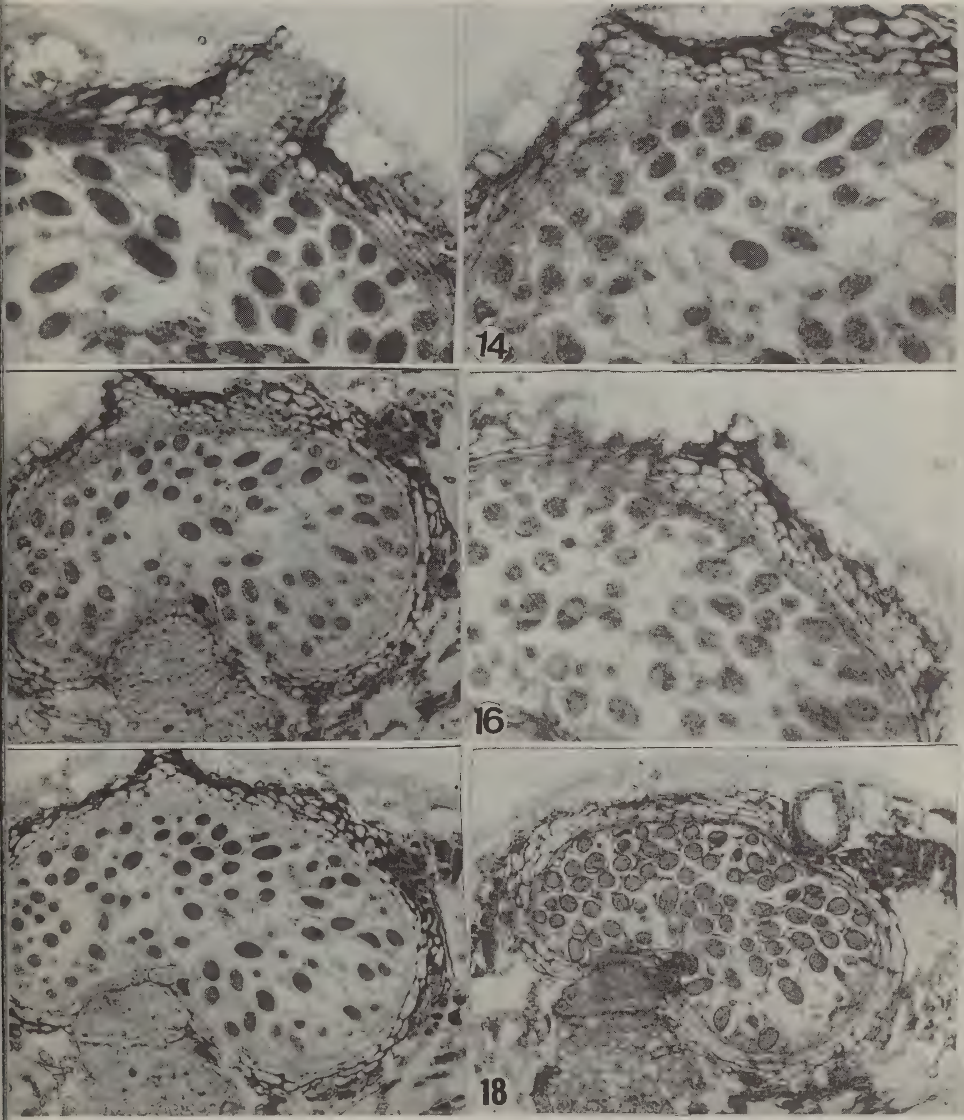


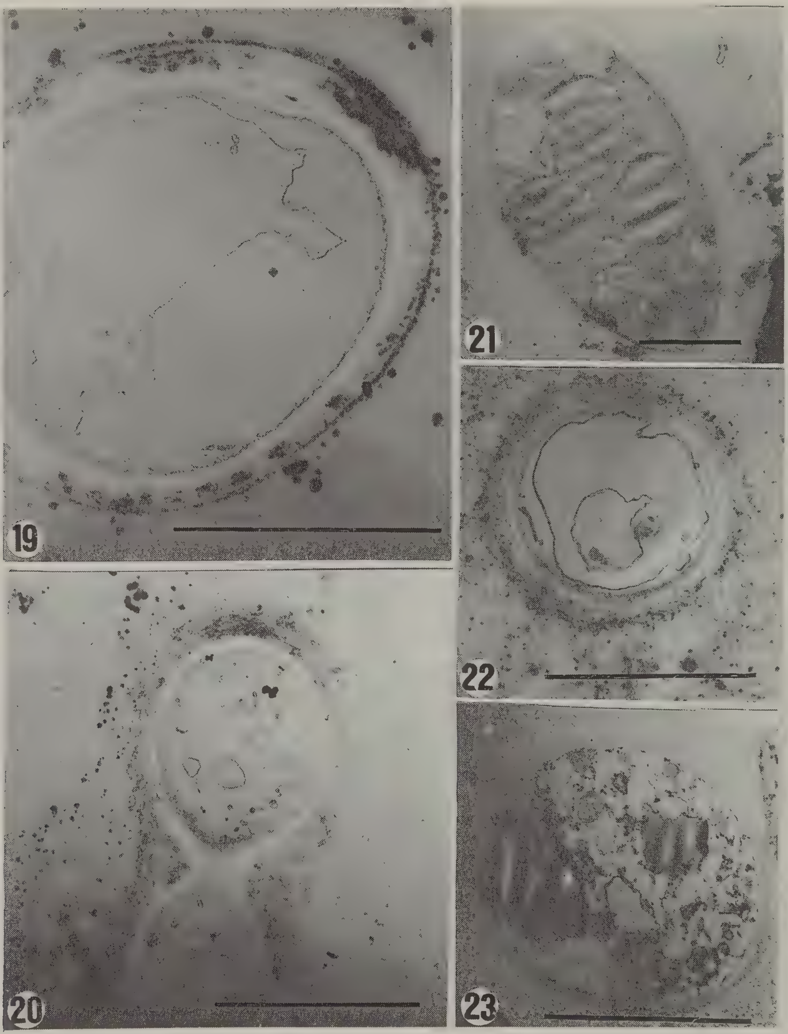
Fig.1. Transverse section of pycnidial primordium x 300 Figs.2-4. Transverse sections of young primordia showing the formation of central cavity. x 300 Figs.5-6. Transverse sections of young conidiomata showing the central cavities with the disentegrated hyphal fragments. x 300



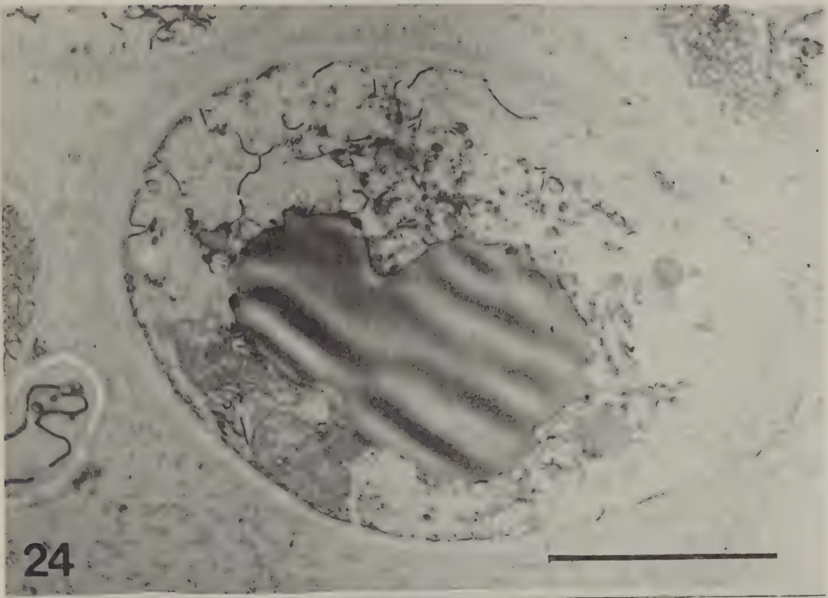
Figs.7-8. Central cavities showing the sloughed off temporary conidiogenous cells with the conidia. x 528. Fig.9. Section of conidioma showing the formation of permanent conidiogenous cells. Note the presence of detached, temporary conidiogenous cells. x 264 Figs.10-12. Vertical sections of mature conidioma. Fig.10 x 264; 11 x 132; 12 x 88.

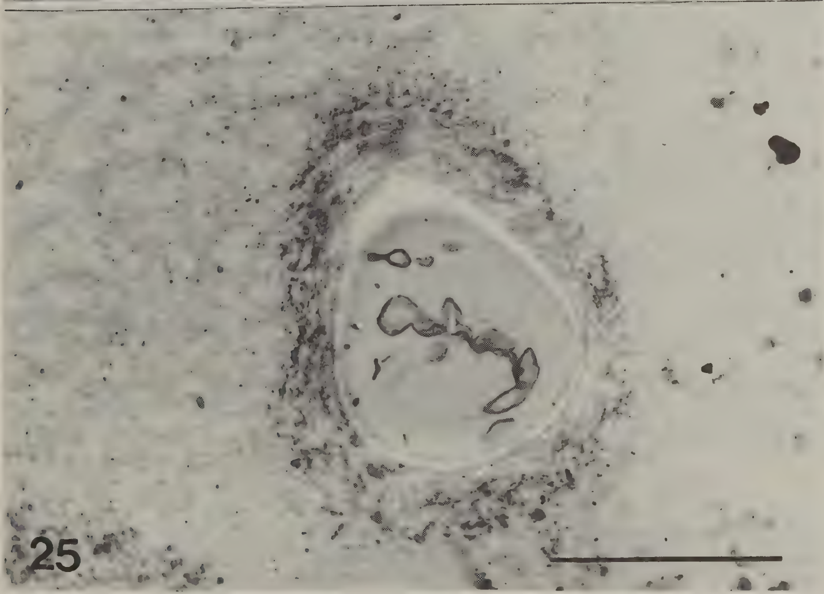


Figs.13-15. Vertical sections of conidiomata on leaf showing the papillae piercing the epidermis of the host 13 x 350, 14 x 350, 15 x 183. Figs. 16-18. Vertical sections of the conidiomata on leaf showing the papillae. 16 x 350, 17-18 x 183.



Figs. 19-25. Transmission electron micrographs of the *Phyllosticta* state. Bar = 3μm. Fig. 19. Section of mature conidium. Note the absence of the sheath surrounding the conidium. Fig. 20. Section of a young conidiogenous cell and conidium. Note the presence of the sheath around the conidiogenous cell and the conidium initial. Fig. 21. Section of a mature conidium showing three nuclei. Note the absence of a sheath around the conidium. Fig. 22. Section of a you ng conidium showing the sheath around the wall. Fig. 23. Section of more or less a mature conidium showing remnants of the sheath around the wall.





Figs. 24-25. Bar = 3μm. Fig. 24. Section of a mature conidium showing remnants of the sheath around the conidium. Fig. 25. Section of a young conidium showing the sheath.

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HYDNANGIUM PILA Pat., AN OLDER NAME FOR *MARTELLIA MEDITERRANEA* Moreno, Galán & Montecchi

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In a recent publication (MORENO, GALAN & MONTECCHI, 1991), a new species belonging to the hypogeous fungi was described, *Martellia mediterranea* (Russulales), having been found in Spain, growing with *Quercus suber* and *Cistus ladanifer*. It was compared with *Zelleromyces stephensii* (Berk.) A. Smith and *Martellia mistiformis* Matt.

It was very surprising for us to note that at almost the same time in a local bulletin (VIDAL, 1991), a fungus "apparently" cospecific with the refered species was described in detail, identified as *Hydnangium pila* (PATOUILLARD, 1910) and with the proposal of the new combination: *Martellia pila* (Pat.) Vidal for it, as well as a list of possible different synonyms.

In order to clarify this hypothetical taxonomical controversy, we decided to study a duplicate of Vidal's material (now in the private herbarium of J. M. Vidal, ref. 910523-3 and 901226-6), which was kindly sent to us by Mr. Vidal, as well as the type of *Hydnangium pila* Pat., which was received from the Farlow Herbarium (Harvard University, Cambridge) -Fig.1-, thanks to the kindness of Dr. D. H. Pfister.

After carefully comparing those specimens with *Martellia mediterranea*, we must conclude that our suspicions were certain and all of them represent the same species, correctly named *Martellia pila* (Pat.) Vidal.

At the same time we consider convenient to point out that the type of *Hydnangium pila*, consisting of three basidiocarps (two immature and the other one well preserved) shows a wide peridium -reaching 200-300 µm in diam.- with no sphaerocysts and having a remarkable gelification (Figs. 5 & 6). On the other hand, basidia are tetrasporic -exceptionally bisporic- measuring 28-40 x 14-17 µm, and cystidia were not observed, probably due to the age of the fructification, according to Vidal's suggestion. In spite of this, the strongly amiloid and spiny basidiospores, 9-11 x 9-10 µm, are good diagnostic characters (Figs. 2-4).

ACKNOWLEDGEMENTS

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LITERATURE CITED

MORENO G., GALAN, R. & MONTECCHI, A. (1991). Hypogeous fungi from Peninsular Spain. II. *Mycotaxon* 42:201-238.

PATOUILLARD, N. (1910).Note sur trois espèces d'*Hydnangium* de la flore du Jura. *Bull. Soc. Mycol. France* 26:199-204.

VIDAL, J. M. (1991). Contribución al conocimiento de la flora micológica del Baix Empordà y zonas limítrofes (Catalunya). IV. Hongos hipogeos (Zygomycotina, Ascomycotina y Basidiomycotina). *Butll. Soc. Catalana Micol.* 14-15:143-194.

Figs. 1–6. *Hydnangium pila* Pat., type: Fig. 1. Original label handwritten by Patouillard. Figs. 2-4. Basidiospores. Fig.5. Cross-section of a sporocarp under light microscope. Fig.6. Texture of the peridium.

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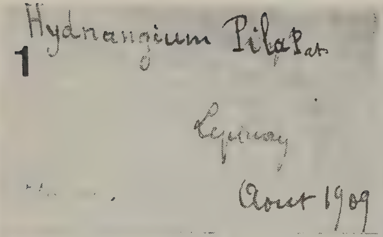

Hydnangium Pila Pat.

Lepinay

Aout 1909

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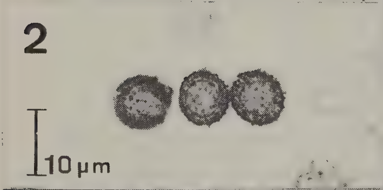

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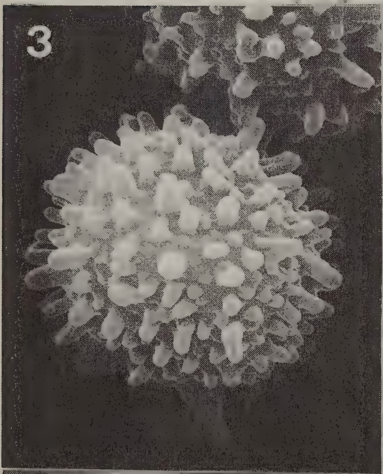

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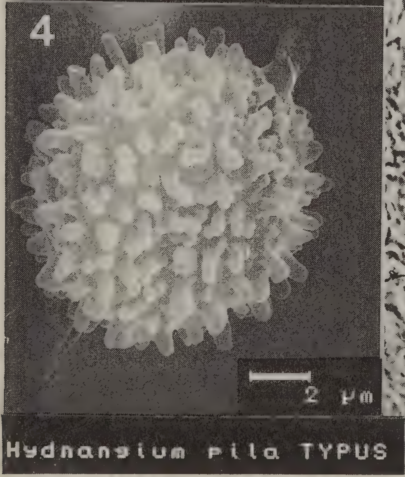
2 µm
Hydnangium pila TYPUS

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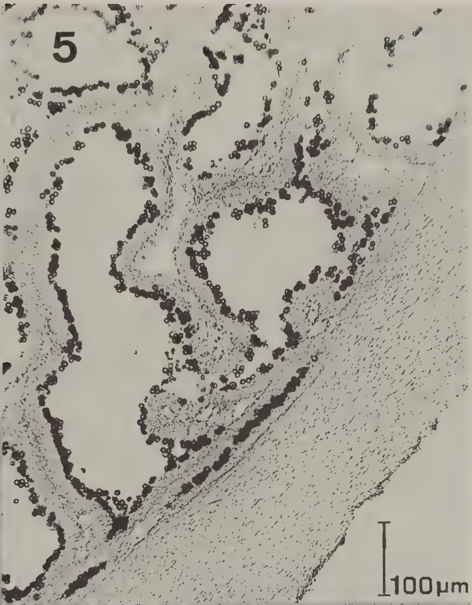

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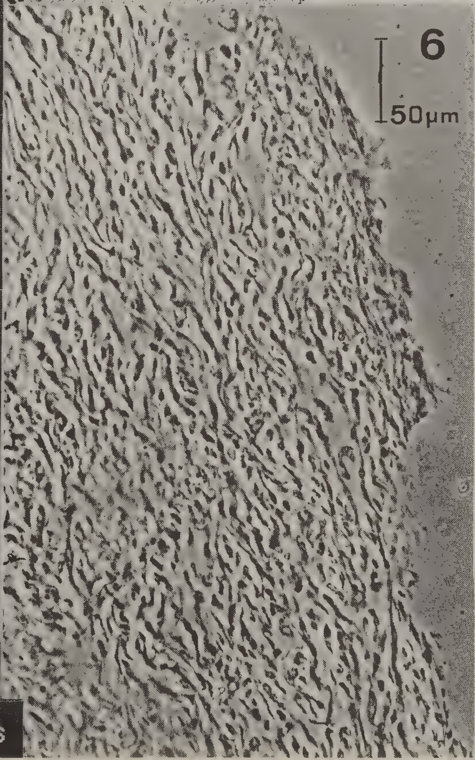

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COMPUTER CODING OF STRAIN FEATURES OF THE GENUS RHIZOPUS

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ABSTRACT

Members of the fungal genus *Rhizopus* play important roles in human, animal, and plant disease and in the fermentation industry. Identification of *Rhizopus* species is based primarily on the morphology of sporangiosporogenous structures, zygospores, and asexual reproductive structures. The standardized coding system, the RKC Code, used for computer storage and analysis of microbial strain data was expanded to include features specific to the identification of *Rhizopus* species.

BACKGROUND AND DISCUSSION

Members of the genus *Rhizopus* occur as saprophytes on plant debris in soil. Many are known to cause soft rots or spoilage of vegetables and fruits. Some are etiologic agents of mucormycosis in humans and animals. Species of *Rhizopus* play important roles in the fermentation industry, especially in the production of enzymes (e.g., glucoamylase and lipase), organic acids, alcohol, and fermented foods such as bongkrek, lao-chao, tauco, and tempeh (Inui *et al.*, 1965; Alexopoulos and Mims, 1979).

The genus *Rhizopus* belongs to the family Mucoraceae under the order Mucorales. The genus was established by Ehrenberg (1820) and its history first reviewed by Zimmermann (1871). *Rhizopus* taxonomy has been the subject of many well known reports including those of Fischer (1892), Lendner (1908), Hanzawa (1915), Zycha (1935), Zycha *et al.* (1969), Naumov (1939), Inui *et al.* (1965), Dabinett and Wellman (1973), Schipper (1984), Schipper and Stalpers (1984), and Liou *et al.* (1990).

The taxonomy of Mucorales has been based primarily on morphological characteristics of sporangiosporogenous structures and zygospores. The genus *Rhizopus*, based on the type species *R. stolonifer* (Ehrenberg:Fries) Vuillemin, is characterized by mycelia bearing stolons and rhizoids and by formation of sporangiophores arising from the points of rhizoid attachment. Sporangia are differentiated at the tips of sporangiophores and are spherical (globose) with columellae and apophyses. Sporangiospores are produced within the sporangium outside the columellae and are mostly regular in shape and striated (Hesseltine and Ellis, 1961). Although the zygospore is the major morphological characteristic used for species delineation, asexual reproductive structures are most commonly used in routine identification of *Rhizopus* cultures.

Since the genus *Rhizopus* was established, more and more differential characters were used for species delineation, and, as a consequence, many species in the genus were described. However, species differentiation was often based on minor differences. In a numerical taxonomic analysis of data previously published by Inui *et al.* (1965), Dabinett and Wellman (1973) found that many of the 34 taxa included in the analysis were very closely related and that few of the 133 physiological and 16 morphological characters contributed significantly to the classification. More recently, other techniques have been used to study the taxonomy of the genus *Rhizopus*, including scanning electron microscopy of spore ornamentation (Schipper and Stalpers, 1984), mating experiments (Schipper, 1984; Schipper and Stalpers, 1984), and DNA homology studies (Ellis, 1985, 1986).

Many previously described *Rhizopus* species are now considered to be synonymous, and the number of recognized species has been reduced considerably. Schipper (1984) and Schipper and Stalpers (1984) recognized only five species. Only two species were retained in the *R. stolonifer*-group -- *R. stolonifer* and *R. sexualis*, each with two varieties. In the *R. microsporus*-group, two species were also retained -- *R. homothallicus* and *R. microsporus*, the latter with four varieties.

The fifth species was *R. oryzae*. An additional species, *R. azygosporus*, was subsequently described by Yang and Jong (1984).

Use of a standardized vocabulary for coding microbial strain data facilitates computer storage, retrieval, analysis, and exchange of such data. Data encoded in this manner can be used to build computer databases for study of taxonomic relationships and construction of identification keys or probability matrices for computer-aided identification of new isolates. In this communication, we present a comprehensive set of features important in the differentiation of *Rhizopus* species that have been incorporated into an existing computer coding system, the RKC Code.

The RKC Code (after the original authors -- Rogosa, Krichevsky, and Colwell, 1971) is an open-ended, statement-oriented controlled vocabulary of descriptors of strain characteristics or features. The RKC Code was developed originally for bacterial strains and later expanded to include features specific for algae, protozoa, and selected groups of fungi and to allow coding of characteristics such as serology, phage typing, properties of nucleic acids, and quantitative antimicrobial susceptibility (Rogosa *et al.*, 1986). More recently, the RKC Code was further expanded to include features used to characterize yeasts (Jong *et al.*, 1988), the saprolegnian fungi (Jong *et al.*, 1991), and the fungal genera *Phytophthora* (Jong *et al.*, 1989) and *Pythium* (Jong *et al.*, 1992).

The set of characteristics developed for use with *Rhizopus* species is presented in the list below. Although some of these features were already part of the RKC Code, many of the descriptors are unique to *Rhizopus* species and were created specifically for this genus. New features added to the RKC Code for the *Rhizopus* species are marked with an "*" in the list. The features include morphological descriptions of rhizoids, stolons, sporangiophores, sporangia, columellae, sporangiospores, zygospores, azygospores, suspensors, and chlamydospores; colony characteristics; and growth temperatures. The terms used for morphological descriptions are based on the descriptions given in Hawksworth *et al.*, 1983.

Rhizoids

008342: Hyphae are septate.
008417: Rhizoids (root-like hyphae) are present.
*043192: Rhizoid system is complex (highly branched).
*043193: Rhizoids are pigmented.
*043194: Rhizoids are brown.
*043195: Rhizoids are black.

Stolons

008420: Stolons are present.
*043196: Stolons are pigmented.
*043197: Stolons are brown.
*043198: Stolons are 0.1-1.0 μ wide.
*043199: Stolons are 1.1-2.0 μ wide.
*043200: Stolons are 2.1-3.0 μ wide.
*043201: Stolons are 3.1-4.0 μ wide.
*043202: Stolons are 4.1-5.0 μ wide.
*043203: Stolons are 5.1-6.0 μ wide.
*043204: Stolons are 6.1-7.0 μ wide.
*043205: Stolons are 7.1-8.0 μ wide.
*043206: Stolons are 8.1-9.0 μ wide.
*043207: Stolons are 9.1-10 μ wide.
*043208: Stolons are 11-12 μ wide.
*043209: Stolons are 13-14 μ wide.
*043210: Stolons are 15-16 μ wide.
*043211: Stolons are 17-18 μ wide.
*043212: Stolons are 19-20 μ wide.
*043213: Stolons are > 20 μ wide.

Sporangiophores

008539: Sporangia are on sporophores (sporangiophores).
*043214: Sporangiophores occur singly.
*043215: Sporangiophores occur in pairs.
*043216: Sporangiophores occur in groups of 3-4.
*043217: Sporangiophores are straight (erect).

008786: Sporangiophores are branched.
008787: Sporangiophore branching is irregular.
*043218: Sporangiophore branching is dichotomous.
*043219: Sporangiophores have swellings.
008792: Swellings are present at branch points of sporangiophore.
008562: Apophyses are present.
*043220: Sporangiophores are pigmented.
*043221: Sporangiophores are brown.
*043222: Sporangiophores are black.
*043223: Sporangiophores are < 201 μ long.
*043224: Sporangiophores are 201-300 μ long.
*043225: Sporangiophores are 301-400 μ long.
*043226: Sporangiophores are 401-500 μ long.
*043227: Sporangiophores are 501-600 μ long.
*043228: Sporangiophores are 601-700 μ long.
*043229: Sporangiophores are 701-800 μ long.
*043230: Sporangiophores are 801-900 μ long.
*043231: Sporangiophores are 901-1000 μ long.
*043232: Sporangiophores are 1001-1500 μ long.
*043233: Sporangiophores are 1501-2000 μ long.
*043234: Sporangiophores are 2001-3000 μ long.
*043235: Sporangiophores are > 3000 μ long.
*043236: Sporangiophores are 0.1-1.0 μ wide.
*043237: Sporangiophores are 1.1-2.0 μ wide.
*043238: Sporangiophores are 2.1-3.0 μ wide.
*043239: Sporangiophores are 3.1-4.0 μ wide.
*043240: Sporangiophores are 4.1-5.0 μ wide.
*043241: Sporangiophores are 5.1-6.0 μ wide.
*043242: Sporangiophores are 6.1-7.0 μ wide.
*043243: Sporangiophores are 7.1-8.0 μ wide.
*043244: Sporangiophores are 8.1-9.0 μ wide.
*043245: Sporangiophores are 9.1-10 μ wide.
*043246: Sporangiophores are 11-15 μ wide.
*043247: Sporangiophores are 16-20 μ wide.
*043248: Sporangiophores are 21-25 μ wide.
*043249: Sporangiophores are 26-30 μ wide.
*043250: Sporangiophores are > 30 μ wide.

Sporangia

043074: Sporangia are present.
008811: Sporangia are terminal.
008558: Sporangia are spherical (length to breadth ratio is 1.0-1.05).
008815: Sporangia are prolate spheroidal (length to breadth ratio is 1.06-1.15).
008563: Sporangial walls are smooth.
008199: Sporangial wall disintegrates concurrently with release of spores.
*043251: Sporangia are powdery.
008829: Sporangia are pigmented.
*043252: Sporangia are blue.
*043253: Sporangia are brown.
*043254: Sporangia are gray.
*043255: Sporangia are black.
008578: Sporangia are 1.0-2.0 μ wide.
008579: Sporangia are 2.1-3.0 μ wide.
008580: Sporangia are 3.1-4.0 μ wide.
008581: Sporangia are 4.1-5.0 μ wide.
008582: Sporangia are 5.1-10 μ wide.
008583: Sporangia are 11-15 μ wide.
008584: Sporangia are 16-20 μ wide.
008585: Sporangia are 21-30 μ wide.
*043256: Sporangia are 31-40 μ wide.
*043257: Sporangia are 41-50 μ wide.
*043258: Sporangia are 51-60 μ wide.
*043259: Sporangia are 61-70 μ wide.
*043260: Sporangia are 71-80 μ wide.
*043261: Sporangia are 81-90 μ wide.
*043262: Sporangia are 91-100 μ wide.
*043263: Sporangia are 101-150 μ wide.
*043264: Sporangia are 151-200 μ wide.
*043265: Sporangia are 201-250 μ wide.
*043266: Sporangia are 251-300 μ wide.
*043267: Sporangia are 301-350 μ wide.
*043268: Sporangia are 351-400 μ wide.
*043269: Sporangia are > 400 μ wide.

Columellae

008561: Columellae are formed.
*043270: Columellae are spherical (length to breadth ratio is 1.0-1.05).
*043271: Columellae are prolate spheroidal (length to breadth ratio is 1.06-1.15).
*043272: Columellae are broadly ellipsoidal (length to breadth ratio is 1.16-1.30).
*043273: Columellae are ellipsoidal (length to breadth ratio is 1.31-1.6).
*043274: Columellae are conical.
*043275: Columellae are applanate (flattened).
*043276: Columellae are pyriform (pear-shaped, attached at narrow end).
*043277: Columellae are obpyriform (pear-shaped, attached at broad end).
*043278: Columellae are cylindrical.
*043279: Columellae are obovoid (egg-shaped, attached at narrow end).
*043280: Columellae have collars.
*043281: Columellae are pigmented.
*043282: Columellae are gray.
*043283: Columellae are brown.
*043284: Columellae are 0.1-1.0 μ long.
*043285: Columellae are 1.1-2.0 μ long.
*043286: Columellae are 2.1-3.0 μ long.
*043287: Columellae are 3.1-4.0 μ long.
*043288: Columellae are 4.1-5.0 μ long.
*043289: Columellae are 5.1-6.0 μ long.
*043290: Columellae are 6.1-7.0 μ long.
*043291: Columellae are 7.1-8.0 μ long.
*043292: Columellae are 8.1-9.0 μ long.
*043293: Columellae are 9.1-10 μ long.
*043294: Columellae are 11-20 μ long.
*043295: Columellae are 21-30 μ long.
*043296: Columellae are 31-40 μ long.
*043297: Columellae are 41-50 μ long.
*043298: Columellae are 51-60 μ long.
*043299: Columellae are 61-70 μ long.

*043300: Columellae are 71-80 μ long.
*043301: Columellae are 81-90 μ long.
*043302: Columellae are 91-100 μ long.
*043303: Columellae are 101-150 μ long.
*043304: Columellae are 151-200 μ long.
*043305: Columellae are > 200 μ long.
*043306: Columellae are 0.1-1.0 μ wide.
*043307: Columellae are 1.1-2.0 μ wide.
*043308: Columellae are 2.1-3.0 μ wide.
*043309: Columellae are 3.1-4.0 μ wide.
*043310: Columellae are 4.1-5.0 μ wide.
*043311: Columellae are 5.1-6.0 μ wide.
*043312: Columellae are 6.1-7.0 μ wide.
*043313: Columellae are 7.1-8.0 μ wide.
*043314: Columellae are 8.1-9.0 μ wide.
*043315: Columellae are 9.1-10 μ wide.
*043316: Columellae are 11-20 μ wide.
*043317: Columellae are 21-30 μ wide.
*043318: Columellae are 31-40 μ wide.
*043319: Columellae are 41-50 μ wide.
*043320: Columellae are 51-60 μ wide.
*043321: Columellae are 61-70 μ wide.
*043322: Columellae are 71-80 μ wide.
*043323: Columellae are 81-90 μ wide.
*043324: Columellae are 91-100 μ wide.
*043325: Columellae are 101-150 μ wide.
*043326: Columellae are 151-200 μ wide.
*043327: Columellae are > 200 μ wide.

Sporangiospores

008173: Asexual spores (sporangiospores) are produced in sporangia (spore vesicles).
008592: Sporangiospores occur in masses.
008595: Sporangiospores are spherical (length to breadth ratio is 1.0-1.05).
*043328: Sporangiospores are prolate spheroidal (length to breadth ratio is 1.06-1.15).

*043329: Sporangiospores are broadly ellipsoidal (length to breadth ratio is 1.16-1.30).
043047: Sporangiospores are ellipsoidal (length to breadth ratio is 1.31-1.6).
*043330: Sporangiospores are angular.
*043331: Sporangiospores are fusiform.
043053: Sporangiospores are irregular in shape.
*043332: Surfaces of sporangiospores are striated.
043054: Surfaces of sporangiospores are smooth.
043056: Surfaces of sporangiospores are spiny.
043057: Surfaces of sporangiospores are warty.
043061: Sporangiospores are pigmented.
043068: Sporangiospores are brown.
043067: Sporangiospores are black.
008602: Sporangiospores are 0.1-1.0 μ wide.
008603: Sporangiospores are 1.1-2.0 μ wide.
008604: Sporangiospores are 2.1-3.0 μ wide.
*043333: Sporangiospores are 3.1-4.0 μ wide.
*043334: Sporangiospores are 4.1-5.0 μ wide.
*043335: Sporangiospores are 5.1-6.0 μ wide.
*043336: Sporangiospores are 6.1-7.0 μ wide.
*043337: Sporangiospores are 7.1-8.0 μ wide.
*043338: Sporangiospores are 8.1-9.0 μ wide.
*043339: Sporangiospores are 9.1-10 μ wide.
*043340: Sporangiospores are > 10 μ wide.
008597: Sporangiospores are 0.1-1.0 μ long.
008598: Sporangiospores are 1.1-2.0 μ long.
008599: Sporangiospores are 2.1-3.0 μ long.
008600: Sporangiospores are 3.1-4.0 μ long.
008601: Sporangiospores are 4.1-5.0 μ long.
*043341: Sporangiospores are 5.1-6.0 μ long.
*043342: Sporangiospores are 6.1-7.0 μ long.
*043343: Sporangiospores are 7.1-8.0 μ long.
*043344: Sporangiospores are 8.1-9.0 μ long.
*043345: Sporangiospores are 9.1-10 μ long.
*043346: Sporangiospores are 11-12 μ long.
*043347: Sporangiospores are 13-14 μ long.
*043348: Sporangiospores are 15-16 μ long.
*043349: Sporangiospores are 17-18 μ long.

*043350: Sporangiospores are 19-20 μ long.
*043351: Sporangiospores are > 20 μ long.

Sexual Reproduction

008617: Sexual reproduction occurs.
008618: Strain is homothallic (both mating types on same mycelium).
008619: Strain is heterothallic (mating types on separate mycelia).

Zygospores

008627: Zygospores are produced.
*043352: Zygospores are spherical (length to breadth ratio is 1.0-1.05).
*043353: Zygospores are prolate spheroidal (length to breadth ratio is 1.06-1.15).
008628: Zygospores are thick-walled.
008629: Surfaces of zygospores are rough.
008630: Surfaces of zygospores are spiny.
*043354: Surfaces of zygospores are warty.
*043355: Zygospores are pigmented.
*043356: Zygospores are red.
*043357: Zygospores are yellow.
*043358: Zygospores are brown.
*043359: Zygospores are black.
*043360: Zygospores are 0.1-1.0 μ wide.
*043361: Zygospores are 1.1-2.0 μ wide.
*043362: Zygospores are 2.1-3.0 μ wide.
*043363: Zygospores are 3.1-4.0 μ wide.
*043364: Zygospores are 4.1-5.0 μ wide.
*043365: Zygospores are 5.1-6.0 μ wide.
*043366: Zygospores are 6.1-7.0 μ wide.
*043367: Zygospores are 7.1-8.0 μ wide.
*043368: Zygospores are 8.1-9.0 μ wide.
*043369: Zygospores are 9.1-10 μ wide.
*043370: Zygospores are 11-15 μ wide.
*043371: Zygospores are 16-20 μ wide.

*043372: Zygospores are 21-30 μ wide.
*043373: Zygospores are 31-40 μ wide.
*043374: Zygospores are 41-50 μ wide.
*043375: Zygospores are 51-60 μ wide.
*043376: Zygospores are 61-70 μ wide.
*043377: Zygospores are 71-80 μ wide.
*043378: Zygospores are 81-90 μ wide.
*043379: Zygospores are 91-100 μ wide.
*043380: Zygospores are 101-150 μ wide.
*043381: Zygospores are 151-200 μ wide.
*043382: Zygospores are 201-250 μ wide.
*043383: Zygospores are > 250 μ wide.

Azygospores

*043384: Azygospores (parthenogenetic zygospores) are present.
*043385: Azygospores are terminal.
*043386: Azygospores are spherical (length to breadth ratio is 1.0-1.05).
*043387: Azygospores are prolate spheroidal (length to breadth ratio is 1.06-1.15).
*043388: Surfaces of azygospores are rough.
*043389: Surfaces of azygospores are spiny.
*043390: Surfaces of azygospores are warty.
*043391: Azygospores are pigmented.
*043392: Azygospores are brown.
*043393: Azygospores are black.
*043394: Azygospores are 0.1-1.0 μ wide.
*043395: Azygospores are 1.1-2.0 μ wide.
*043396: Azygospores are 2.1-3.0 μ wide.
*043397: Azygospores are 3.1-4.0 μ wide.
*043398: Azygospores are 4.1-5.0 μ wide.
*043399: Azygospores are 5.1-6.0 μ wide.
*043400: Azygospores are 6.1-7.0 μ wide.
*043401: Azygospores are 7.1-8.0 μ wide.
*043402: Azygospores are 8.1-9.0 μ wide.
*043403: Azygospores are 9.1-10 μ wide.
*043404: Azygospores are 11-15 μ wide.
*043405: Azygospores are 16-20 μ wide.

*043406: Azygospores are 21-30 μ wide.
*043407: Azygospores are 31-40 μ wide.
*043408: Azygospores are 41-50 μ wide.
*043409: Azygospores are 51-60 μ wide.
*043410: Azygospores are 61-70 μ wide.
*043411: Azygospores are 71-80 μ wide.
*043412: Azygospores are 81-90 μ wide.
*043413: Azygospores are 91-100 μ wide.
*043414: Azygospores are 101-150 μ wide.
*043415: Azygospores are 151-200 μ wide.
*043416: Azygospores are 201-250 μ wide.
*043417: Azygospores are > 250 μ wide.

Suspensors

008632: Two supporting cells (suspensors) are present.
*043418: Suspensors (supporting cells) are equal in size.
*043419: Both suspensors are spherical (globose).
*043420: Only the larger suspensor is spherical (globose).

Chlamydospores

008363: Chlamydospores are present.
008993: Chlamydospores occur singly.
008994: Chlamydospores are catenulate (in chains).
008996: Chlamydospores are spherical (length to breadth ratio is 1.0-1.05).
*043421: Chlamydospores are prolate spheroidal (length to breadth ratio is 1.06-1.15).
*043422: Chlamydospores are broadly ellipsoidal (length to breadth ratio is 1.16-1.30).
*043423: Chlamydospores are ellipsoidal (length to breadth ratio is 1.31-1.6).
*043424: Chlamydospores are cylindrical.
008426: Chlamydospores are pigmented.
*043425: Chlamydospores are refringent (refractive).
*043426: Chlamydospore walls are smooth.
*043427: Chlamydospores are 0.1-1.0 μ wide.

*043428: Chlamydospores are 1.1-2.0 μ wide.
*043429: Chlamydospores are 2.1-3.0 μ wide.
*043430: Chlamydospores are 3.1-4.0 μ wide.
*043431: Chlamydospores are 4.1-5.0 μ wide.
*043432: Chlamydospores are 5.1-6.0 μ wide.
*043433: Chlamydospores are 6.1-7.0 μ wide.
*043434: Chlamydospores are 7.1-8.0 μ wide.
*043435: Chlamydospores are 8.1-9.0 μ wide.
*043436: Chlamydospores are 9.1-10 μ wide.
*043437: Chlamydospores are 11-15 μ wide.
*043438: Chlamydospores are 16-20 μ wide.
*043439: Chlamydospores are 21-25 μ wide.
*043440: Chlamydospores are > 25 μ wide.
*043441: Chlamydospores are 0.1-1.0 μ long.
*043442: Chlamydospores are 1.1-2.0 μ long.
*043443: Chlamydospores are 2.1-3.0 μ long.
*043444: Chlamydospores are 3.1-4.0 μ long.
*043445: Chlamydospores are 4.1-5.0 μ long.
*043446: Chlamydospores are 5.1-6.0 μ long.
*043447: Chlamydospores are 6.1-7.0 μ long.
*043448: Chlamydospores are 7.1-8.0 μ long.
*043449: Chlamydospores are 8.1-9.0 μ long.
*043450: Chlamydospores are 9.1-10 μ long.
*043451: Chlamydospores are 11-15 μ long.
*043452: Chlamydospores are 16-20 μ long.
*043453: Chlamydospores are 21-25 μ long.
*043454: Chlamydospores are 26-30 μ long.
*043455: Chlamydospores are 31-35 μ long.
*043456: Chlamydospores are 36-40 μ long.
*043457: Chlamydospores are > 40 μ long.

Colony Pigmentation

020037: Nondiffusible pigment is produced.
020001: Colonies are pure (paper) white on solid medium.
020039: Nondiffusible brown pigment is produced.
020043: Nondiffusible golden (yellow) pigment is produced.
020002: Colonies are gray on solid medium.

Growth Temperatures

017032: Growth occurs at 5°C.
017012: Growth occurs at 10°C.
017013: Growth occurs at 15°C.
017066: Growth occurs at 17°C.
017037: Growth occurs at 20°C.
017014: Growth occurs at 25°C.
017033: Growth occurs at 30°C.
017052: Growth occurs at 33°C.
017034: Growth occurs at 35°C.
017074: Growth occurs at 36°C.
017043: Growth occurs at 40°C.
017017: Growth occurs at 45°C.
017018: Growth occurs at 50°C.
017019: Growth occurs at 55°C.
017020: Growth occurs at 60°C.

Source of Isolation

002012: What was the specific source of isolation (e.g., kind of water, soil, etc., species and organ and tissue of plant, animal, etc.)?

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REFERENCES

Alexopoulos, C.J. and Mims, C.W. 1979. Introductory Mycology. John Wiley & Sons, New York, 632 pp.

Dabinett, P.E. and Wellman, A.M. 1973. Numerical taxonomy of the genus *Rhizopus*. Can. J. Bot. **51**:2053-2064.

Ehrenberg, C.G. 1820. De Mycetogenesi. Bonnae.

Ellis, J.J. 1985. Species and varieties in the *Rhizopus arrhizus-Rhizopus oryzae* group as indicated by their DNA complementarity. Mycologia **77**:243-247.

Ellis, J.J. 1986. Species and varieties in the *Rhizopus microsporus* group as indicated by their DNA complementarity. Mycologia **78**:508-510.

Fischer, A. 1892. Phycomycetes. **In** Rabenhorst's Kryptogamenflora, Die Pilze, Vol 4. Kummer, Leipzig, 505 pp.

Hanzawa, J. 1915. Studien uber einige *Rhizopus*-Arten. Mykol. Zentralbl. **5**:230-246.

Hawksworth, D.L., Sutton, B.C., and Ainsworth, G.C. 1983. Ainsworth & Bisby's dictionary of the fungi (including the lichens), 7th ed. Commonwealth Mycological Institute, Kew, Surrey, England, 445 pp.

Hesseltine, C.W. and Ellis, J.J. 1961. Notes on Mucorales, especially *Absidia*. Mycologia **53**:406-426.

Inui, T., Takeda, Y., and Iizuka, H. 1965. Taxonomical studies on genus *Rhizopus*. J. Gen. Appl. Microbiol. **11**(suppl.):1-121.

Jong, S.-C., Davis, E.E., McManus, C., and Krichevsky, M.I. 1991. Computer coding of strain features of the saprolegnian fungi. Mycotaxon **41**:407-418.

Jong, S.-C., Ho, H.H., McManus, C., and Krichevsky, M.I. 1989. Computer coding of strain features of the genus *Phytophthora*. Binary **1**:187-193.

Jong, S.-C., Ho, H.H., McManus, C., and Krichevsky, M.I. 1992. Computer coding of strain features of the genus *Pythium*. Mycotaxon **44**:301-314.

Jong, S.-C., Holloway, L., McManus, C., Krichevsky, M.I., and Rogosa, M. 1988. Coding of strain features for computer-aided identification of yeasts. Mycotaxon **31**:207-219.

Lendner, A. 1908. Les Mucorinées de la Suisse. Matériaux pour la flora cryptogamique Suisse. K.-J Wyss, Berne, 180 pp.

Liou, G.Y., Chen, C.C., Hsu, W.H., and Chien, C.Y. 1990. Atlas of the genus *Rhizopus* and its allies. Mycological monograph No. 3. Food Industry Research and Development Institute, Taiwan, 32 pp.

Naumov, N.A. 1939. Clés des Mucorinées. Encyclopédia mycologique, Vol. 9. Lechevalier, Paris, pp. 1-137.

Rogosa, M., Krichevsky, M.I., and Colwell, R.R. 1971. Method for coding data on microbial strains for computers (edition AB). Int. J. Syst. Bacteriol. **21**:1A-184A.

Rogosa, M., Krichevsky, M.I., and Colwell, R.R. 1986. Coding microbiological data for computers. Springer-Verlag, New York, 299 pp.

Schipper, M.A.A. 1984. A revision of the genus *Rhizopus*. I. The *Rhizopus stolonifer*-group and *Rhizopus oryzae*. Stud. Mycol. **25**:1-19.

Schipper, M.A.A. and Stalpers, J.A. 1984. A revision of the genus *Rhizopus*. II. The *Rhizopus microsporus*-group. Stud. Mycol. **25**:20-34.

Yang, G.F. and Jong, S.C. 1984 A new obligate azygosporic species. Mycotaxon **20**:397-340.

Zimmermann, O.E.R. 1871. Das genus *Mucor*. **In** Programm der Realschule I. Ordnung zu Chemnitz.

Zycha, H. 1935. Pilze II. Mucorineae. **In** Kryptogamenflora der Mark Brandenburg, Vol. 6a. Gebruder Borntraeger, Leipzig, 264 pp.

Zycha, H., Siepmann, R., and Linnemann, G. 1969. Mucorales. Eine Beschreibung aller Gattungen und Arten dieser Pilzgruppe. J. Cramer, Lehre, 355 pp.

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THREE NEW HYALOSCYPHACEOUS FUNGI FROM NORWAY AND GREENLAND

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SUMMARY: Three species of Hyaloscyphaceae from Norway and Greenland, *Urceolella aasii sp. nov.* on *Urtica, Hyalopeziza archangelica sp. nov.* on *Angelica/Heracleum*, and *Hyalopeziza groenlandica sp. nov.* on *Angelica*, are described and briefly discussed. Collections were made by the first author unless otherwise stated.

KEY WORDS: Greenland; Hyaloscyphaceae; Norway

Urceolella aasii Olsen & Haines, *sp. nov.* Fig. 1

Apothecia diametro usque ad .5 mm, aurantio-ochracea. Pili usque ad 250 µm longi, 6-16 µm lati, non-septati, praecrassotunicati, in iodo non colorati, tabida in 3% KOH. Sporae 6.5-9.5 µm longae. 1.0-1.8 µm crassi. Ad caulis emortuis Urticae.

Holotypus: Norway, Nordland, Rana: Ytteren. On *Urtica dioica*. 22 V 1991, S. Olsen. In herb BG.

Etymology: Named in honor of Norwegian mycologist Olav Aas.

Apothecia up to .5 mm diam., orange to ochraceous, seated on very short stipe ca. 2/3 the diam. of the cup, disc orange-ochraceous, exposed and concave when moist, covered by hairs when dry. **Excipulum** thin-walled, buff-orange *textura angularis* composed of cells ca. 12 µm in diam., outer layer flattened, almost forming a cortex. Subhymenium and inner cells of excipulum containing orange oil-globules in revived exiccata. **Hairs** up to 250 µm by 6-16 µm diam., cylindric or tapered to a blunt point at the apex, straight or occasionally slightly curved or forked, non-septate with a fine lumen 1-2 μm wide except at the base where it is wider, hyaline, smooth, arising perpendicularly from the margin or outer exciple, sometimes with a plate-like or rooting base, flexible, not easily breaking, slowly and almost completely dissolving in warm 3% KOH to leave only a ghost-like outline, unchanged in Melzer's solution. Some hairs agglutinated apically by hyaline amorphous matter which stains in cotton blue. Hair walls and lumen unstained with cotton blue. Short cylindrical hairs with hemispherical tips and apically enlarged lumen also present. **Asci** 35-45 (57) x 4.5-6.0 μm, 8-spored, cylindrical or enlarged in the mid portion, subtended by a crozier at least in early development, with a minute apical pore plug which turns bright blue in Melzer's solution. **Spores** 6.5-9.5 1.0-1.8 (2.5) μm, non-septate, cylindric-fusiform, slightly enlarged above, straight or very slightly curved, without conspicuous inclusions. **Paraphyses** evenly cylindrical, 1.3-1.7 μm wide level with the ascus tips in the hymenium, containing yellowish oil globules, straight, unbranched except at the base.

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*Sigurd Olsen died November 23, 1992

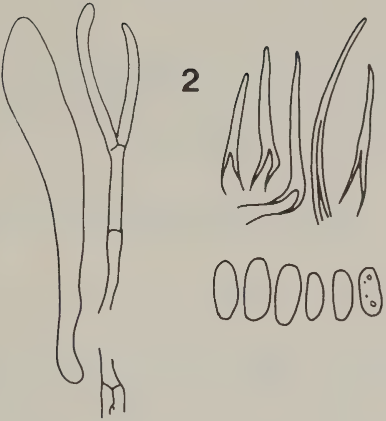
Host: Known only from moist previous years stems of *Urtica dioica* in Spring or summer. The type material also contains *Crocicreas, Leptosphaeria*, and a pycnidial fungus.

Distributions: Known only by three collections from near or above the Arctic Circle in Norway.

Collections examined: NORWAY; Trons., Harstad, Sörvik. 27 VI 1989 on *Urtica dioica* in herb. BG; Nordland, Rana, Ytteren. 25 V 1990 on *Urtica dioica* in herbs. BG, NYS; See also type.

This small, herbicolous discomycete fits into the Hyaloscyphaceous genus *Urceolella* as defined by Korf & Kohn (1980), with its long, thick-walled hairs that dissolve in KOH and remain unstained in Melzer's solution. It is distinct within *Urceolella* with its orange to ochraceous pigmentation and long hairs up to 250 μm arising perpendicularly from the substrate. It appears to be closely related to *U. crispula*, from which it is distinguished by its larger size, larger spores, and colored disc as compared to the watery white disc of *U. crispula*. Raschle (1977) describes *U. crispula* as white or light beige. Another, perhaps even more closely related, though isolated species, *U. tuberculiformis*, has the same type of hairs with T-like bases. This species, as described by Dennis (1963), differs in having no pigmentation, although Raschle (1977) describes it as yellowish white with a thick-walled yellow excipulum, and asci, ca. 70 x 10 μm, longer and broader spores (10-12 x 2.5-3.0 μm), and growing on *Aquilegia* in the USA and *Adenostyles* in Italy.

Figs. 1-5. 1. *Urceolella aasii*, Hairs, asci, paraphyses, and spores from Paratype, Sörvik. 2-4. *Hyalopeziza archangelica*. 2. Asci, paraphyses, hairs, and spores from holotype. 3. Spores and hairs from paratype, Trondheim. 4. Spores from paratype specimen, Skänland. 5. *Hyalopeziza groenlandica* Ascus, paraphyses, hairs, and spores from holotype.



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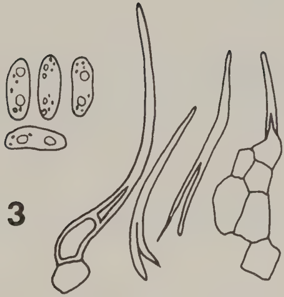

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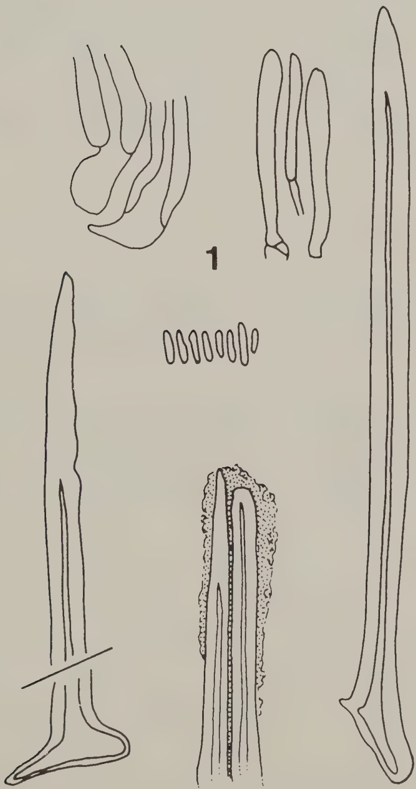

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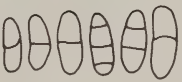

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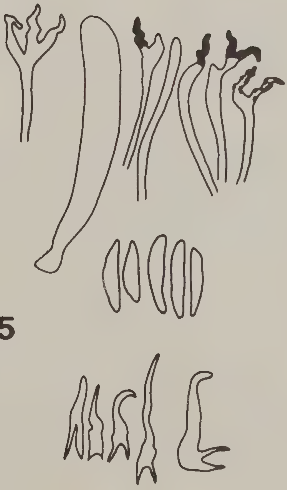

5

Hyalopeziza archangelica Olsen & Sivertsen, *sp. nov.* Fig. 2-4

Apothecia cupulata, sessilia, ad 1 mm diametro, rose, arcte setulosa. Pili hyalini, 25-65 µm longis, basi ad 6 µm crassi, solidis. Asci 70-110 µm longis, 15-17 µm crassi, in Iodo non colorati. Paraphysis cylinribus. Sporae 10-15 (18.5) µm longis, 4.0-6.5 (-7.0) µm crassi, 0-3-septatae. Ad caulis emortuis Angelica et Heracleum.

Holotypus: Norway, Nordland, Rana, Fisktjõnna. On *Angelica archangelica*, 26 V 1990. Olsen & Sivertsen. In herb. BG.

Etymology: Named for its substrate, *Angelica archangelica*.

Apothecia sessile, cupulate, up to 1 mm across, mostly smaller, gregarious, whitish to pink. Rim and flanks set with scattered, short hairs. **Excipulum** of thick-walled, hyaline, angular, ± isodiametric cells 6, 5-10 µm across. **Hairs** 25-70 µm long, refractive, solid above with a lumen at the base, ± straight, rather evenly tapering towards an acute apex. Not loosing glassiness in warm 10% KOH and not colored by Meltzer's or Congo Red. **Asci** 70-110, 15-17 µm thin-walled, some apical thickening when immature, 8-spored, arising from a crozier. **Spores** 10-15 (18.5) x 4-6 (7) µm, hyaline, smooth, 0-2-, mostly 1-septate, often with prominent oil-globules. **Paraphyses** cylindrical, 2.0-2.8 µm thick, with rounded apex, sparingly septate, sometimes branched above the middle, not overtopping the asci, scarce.

Host: On basal parts of previous years stems of *Angelica* and *Heracleum*.

Distribution: Probably widespread over the northern hemisphere, but overlooked because of its small size and nondistinctive color. A specimen cited by Korf (1980) and presumed to be the same, is from Finmark, Norway, but it has not been examined by the authors.

Collections examined: NORWAY, Nordland; Rana, Fisktjönna, 20 V 1991 on *Angelica*, S. Olsen, herbarium BG; Tromso, Skänland, near airport, 11 VI 1991 on *Heracleum*, S. Olsen, herbarium BG; Sør-Tröndelag, Trondheim, Lillegärdsbakken, III 1992, on *Heracleum*, S. Sivertsen, herbarium BG; GREENLAND, Kuànit, east of Godhavn, on *Angelica*, P. Milan Petersen, herbarium CUP as 5946; Also see type.

This is the same fungus from Finmark and Greenland as tentatively refered to as "*Chaetonaevia archangelica*" by Korf (1980). Korf clearly did not intend to legitimize the name according to the code in that publication and since it has so many similarities to *Hyalopeziza*, it will be described here as a *Hyalopeziza* in subgenus *Unguicularia* as defined by Korf & Kohn (1980). Its hairs are unchanged by KOH, and the lumen is present only at the base. The excipulum is composed of ± isodiametric angular cells, which, according to Huhtinen (1987) is acceptable in the genus.

The species seems to be closely related to *Hyalopeziza raripila* (Höhn.) Huhtinen, but differs in its larger size, different color, longer hairs, asci, and spores which are septate at maturity.

Hyalopeziza groenlandica Olsen, *sp. nov.* Fig. 5

Apothecia gregaria, cupulata, ad 0.5 mm lata, sessilia, ochraceo-rosei. Pili hyalini, ad 30 µm longis, in apicem solidis attenuatis. Asci 55-60 µm longis, octospori, poro in Iodi non colorati. Paraphyses cylindracea, apicem solidis attenuatis. Sporae 15-20 x 2.8-4.0 µm. Ad caulis emortuis Angelicae.

Holotypus: Greenland, Kuànit, approx. 4 km. east of Godhavn. Leg. P. Milan Petersen 5 VIII 1970 in herbarium CUP (as CUP 59588).

Etymology: For the type locality, Greenland.

Apothecia yellowish-pink, sessile, cupulate, gregarious, up to 0.5 mm across. Margin with short, hyaline hairs. **Excipulum** of slightly thick-walled, elongate, hyaline cells. **Hairs** 25-35 µm long, refractive, tapering, irregularly flexuose, hooked apically, straight or sharply bent basally, with lumen at the base, refractivity not lost in warm 10% KOH, without color change in Meltzer's solution. **Asci** 55-60 µm long, somewhat thick-walled, 8-spored, without croziers, pore not blued in Melzer's solution even with KOH pretreatment. **Spores** 15-20 x 2.8-4.0 µm, wide fusiform, slightly curved, aseptate, aguttulate. **Paraphyses** numerous, with irregular refractive, apical protuberances, unchanged in KOH or Melzer's, slightly exceeding the asci.

Host: Previous year's stems of *Angelica*.

Distribution: So far known only from the type collection.

Korf (1980) tentatively assigned the name "*Laetinaevia archangelica*" to this collection, but he was clear in not formally describing it as a new species. The first author is inclined to assign this species to *Hyalopeziza* subgenus *Unguiculella (sensu strictu)* Korf & Kohn (1980) on the basis of its glassy hairs and paraphyses. This combination requires that a species name other than Korf's be chosen as the epithet "*archangelica*" is occupied by the new species *Hyalopeziza archangelica* Olsen & Sivertsen described above. Korf stresses the paraphyses, which he described as "coiled" and, although the general appearance is very much the same as *H. archangelica* Olsen & Sivertsen it differs in the glassy protuberances of the paraphyses, as well as its quite different spores.

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LITERATURE CITED

Dennis, R. W. G. 1963. A redisposition of some Fungi ascribed to the Hyaloscyphaceae. Kew Bulletin 17: 319-379.

Huhtinen, S. 1987 (1988). Five glassy-haired Hyaloscyphaceae. Karstenia 27: 8-14.

Korf, R. P. 1980. Inoperculate discomycetes of the arctic and alpine zones of Finmark, Lapland, and Greenland. In G. Laursen & J. Ammirati. Arctic and Alpine Mycology I: 27-37.

Korf, R. P. & Linda M. Kohn 1980. Revisionary studies in the Hyaloscyphaceae. I. On Genera with "glassy" hairs. Mycotaxon 10: 503-512.

Raschle, P. 1977. Taxonomische Untersuchungen and Ascomyceten aus der Familie der Hyaloscyphaceae Nannfeldt. Sydowia 29: 170-236.

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TAXONOMIC HISTORY OF THE OOMYCETE GENUS *THRAUSTOTHECA*

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ABSTRACT

The nomenclature of *Thraustotheca* (Saprolegniales) is reviewed. The rationale for the proper citation of authorship of *T. clavata* as (de Bary ex Büsgen) Humphrey is explained. It is concluded that at present only two validly published or adequately described species of *Thraustotheca* should be recognized, *T. clavata* and *T. primoachlya*. The inclusion of the latter taxon in the genus is questioned based on current consideration of primary sporangial characters as most significant in generic delimitations.

Many genera of Oomycetes need contemporary taxonomic and nomenclatural review. Sparrow's 1960 review of Oomycete genera in his monumental work on Phycomycetes is the most recent extensive synoptic treatment of the family Saprolegniaceae. Dick (1973) provided a list of genera and species of the Saprolegniaceae in chronological order of their descriptions. New species of the family have been described in more recent years, yet within the last forty years the only genera of Saprolegniaceae which have been monographed are *Achlya* (Johnson, 1956), *Aphanomyces* (Scott, 1961) and *Saprolegnia* (Seymour, 1970). In addition

Langsam (1986, 1987) has carried-out revisionary investigations on the genus *Brevilegnia* . In the following account we review the current taxonomic state of one genus of the Saprolegniaceae, *Thraustotheca* Humphrey. We clarify nomenclatural errors and identify taxa which require revisionary study.

History and Authorship of *Thraustotheca clavata*

The original species of the genus *Thraustotheca* Humphrey (1893), *T. clavata* , is based on the taxon *Dictyuchus clavatus* . Authorship of the epithet *clavatus* is usually credited (Coker and Hyman, 1912; Coker, 1923; Coker and Matthews, 1937; Shanor, 1937; Wolf, 1944; Sparrow, 1960) solely to Anton de Bary (1888), although some also noted (Coker and Hyman, 1912; Weston, 1918; Coker and Matthews, 1937; Shanor, 1937) that Büsgen (1882) first incidentally published the species (i.e., *D. clavatus*).

Büsgen's (1882) publication on sporangial and spore formation provided an extensive description of asexual development of *D. clavatus* , and as well an account of sexual structures of the organism, in effect a complete description. However, Büsgen credited the species to de Bary, who had received it in 1880 as part of a mixed algal collection obtained by E. Stahl at Vendenheim, Germany. A preferred citation of authorship of *Dictyuchus clavatus* would thus be de Bary ex Büsgen (1882) or simply Büsgen (cf. Article 46.3, International Code of Botanical Nomenclature, Grueter et al., 1988).

De Bary mentioned *Dictyuchus clavatus* in his 1884 text without description, referencing his student's (i.e., M. Büsgen's) dissertation. De Bary's 1888 actual description of the taxon provided additional morphological information, but this is not relevant to the point of its valid publication. In fact, de Bary's 1888 publication was a posthumous paper edited by Solms-Laubach (Weston, 1918), and it is difficult to ascertain de Bary's intent as to the description of *D. clavatus* as a new species. Regardless, a proper citation of authorship under *Thraustotheca* would be *T. clavatus* (de Bary ex Busgen) Humphrey (1893), as listed in Farr et al. (1979).

Concept of the Genus *Thraustotheca*

Solms-Laubach (in de Bary, 1888) first noted the possible generic distinction of *D. clavatus* within the Saprolegniales; this was reiterated by Fischer (1892). Humphrey subsequently (1893) described the genus *Thraustotheca* based on this taxon, but without benefit of living material. Whereas Saccardo (1899) cited the date of publication of the generic name as 1892, Clements and Shear (1931) cited it as 1893. This discordance over date of publication is resolved by understanding that Humphrey read his manuscript on Saprolegniaceae of the United States before the American Philosophical Society in November of 1892, but the Proceedings were published in 1893, the actual year of effective publication of the name. Coker and Hyman (1912) clearly stated the morphological delimitation of *Thraustotheca* (i.e., *T. clavata*). Over the years the generic concept of *Thraustotheca*, however, has evolved (Coker and Couch, 1923, 1924; Coker and Braxton, 1926; Coker, 1927; Coker and Matthews, 1937; Wolf, 1944; Sparrow, 1960), and we can summarize it now as:

> those Saprolegniaceae producing a thraustothecoid sporangium (=generally club-shaped or subcylindric with an inoperculate, quickly disintegrating or rupturing sporangial wall), which contains no dictyuchoid network but which usually contains numerous primary cystospores (i.e., primary motile stage suppressed); oogonia with multiple oospores; and hyphae with relatively broad diameters which form a spreading hyphal mass.

These characters, in combination and in predominance, distinguish *Thraustotheca* from other genera of the Saprolegniaceae which are often considered morphologically similar: e.g. *Achlya, Brevilegnia, Calyptralegnia, Dictyuchus,* and *Geolegnia.*

Setting generic limits within the Saprolegniaceae is sometimes problematic because of morphological plasticity. Some genera exhibit more than one type of sporangial discharge, yet it is generally accepted that the mechanism of sporangial discharge is a primary character distinguishing genera. For example, one species of *Thraustotheca* recognized (*T. primoachlya*) does not exclusively produce sporangia with thraustothecoid type of spore discharge. Decisions on generic placements have traditionally been based on which sporangial type predominates (Coker, 1923). Instead, more recently, the type of spore discharge found in first-formed sporangia (Langsam, 1986) has been used for generic assignment. Accordingly, Langsam (1986) transferred *Brevilegnia bispora* to *Achlya* because of achlyoid spore discharge of primary sporangia and minisporangia. These viewpoints (i.e, relative importance of predominant versus initial sprorangial type) caution that clearer delimitation of taxa requires developmental studies of isolates grown under varying environmental conditions, as well as numerical comparison of genera using all putatively distinguishing generic characteristics.

Nomenclatural Summary

Several taxa (in addition to *T. clavata*) have been described within *Thraustotheca*, two of these (*T. achlyoides* and *T. unisperma*) eventually constituting bases for recognition of new genera (respectively *Calyptralegnia* and *Brevilegnia*) of Oomycetes. Following is a chronological nomenclatural summary of names published as taxa of *Thraustotheca*. Names in boldface are presently construed as valid taxa of the genus.

Thraustotheca Humphrey, 1893

Thraustotheca clavata (de Bary ex Büsgen) Humphrey, 1893.
The basionym is *Dictyuchus clavatus* de Bary ex Büsgen, 1882. Citation as *D. clavatus* Büsgen is equally permissible (Article 46.3, ICBN).

Thraustotheca caucasica Voronov, 1922. This name has been overlooked by virtually all authors. It was, however, noted in 1969 in Index of Fungi, a Supplement to Petrak's Lists. Although validly published, *T. caucasica* must be considered a doubtful or exluded taxon. Though seemingly similar to *T. primoachlya* , e.g., possessing tuberculate oogonia, there is insufficient descriptive information (including the lack of an illustration, as well as any information on antheridia) to make a positive determination of identity. Should it be possible to determine that it is the same as *T. primoachlya* , the epithet *caucasica* would assume priority.

Thraustotheca achlyoides Coker and Couch, 1923. = *Calyptralegnia achlyoides* (Coker and Couch) Coker, 1927.

Thraustotheca primoachlya Coker and Couch, 1924.
Although we are recognizing *T. primoachlya* herein, further assessment of this taxon as a species of *Thraustotheca* is needed. In contrast to *T. clavata*, this species has androgynous antheridial branches and primary sporangia of the achlyoid type (producing the usually predominating thraustothecoid type sporangia later).

Thraustotheca unisperma Coker and Braxton, 1926. = *Brevilegnia unisperma* (Coker and Braxton) Coker and Couch in Coker, 1927. This is tantamount to transfer of *Thraustotheca unisperma* var. *unisperma*, an autonym created when var. *litoralis* (see below) was described (Coker and Braxton, 1926).

Thraustotheca unisperma var *litoralis* Coker and Braxton, 1926. = *Brevilegnia unisperma* var. *litoralis* (Coker and Braxton) Coker and Couch in Coker, 1927. In Coker's work, the transfer to *Brevilegnia* is erroneously credited to Coker and Braxton. Because of similarities of sporangial structure and dehiscence, Salvin (1942) seemingly proposed that *Brevilegnia* be only a subgenus of *Thraustotheca* , and hence that all taxa described in or transferred to *Brevilegnia* should be returned to *Thraustotheca.* Based on total morphology (including one-spored oogonia), we favor retention of *Brevilegnia* as a separate genus, and do not favor such transfer of taxa back to *Thraustotheca* . We note that Langsam (1987), though excluding certain species, nonetheless retained the genus *Brevilegnia* .

Thraustotheca irregularis Coker and Ward in Ward, 1939. This is a nomen invalidum, lacking a Latin diagnosis. Should it become desirable to recognize this taxon, it would be necessary to provide such descriptive information in Latin. Dick (1973) questioned the status of *T. irregularis*. Johnson (1956) considered the taxon possibly similar to *Achlya dubia* Coker (1923), in effect questioning its acceptance as a species.

Two taxa, thus, are presently recognized as valid species of ***Thraustotheca*** , ***T. clavata*** and ***T. primoachlya*** . This is in fact the composition of the genus arrived at de facto by Coker (1927) when *T. achlyoides* and *T. unisperma* were transferred out of the genus. This circumscription recognizes that *T. primoachlya* does not exclusively produce thraustothecoid sporangia, and hence at this time we are following Coker's (1923) conservative concept of predominance of sporangial discharge for generic assignment. *Thraustotheca clavata* shows only thraustothecoid sporangia, whereas *T. primoachlya* demonstrates a progression from achlyoid to thraustothecoid sporangial structures. Since *Achlya dubia* Coker , like *T. primoachlya* , can produce both achlyoid and thraustothecoid types of sporangia, both taxa should be investigated further. In fact, based on diclinous antheridia and primary sporangia of the thraustothecoid type, *Achlya dubia* may be more similar to *T. clavata* than is *T. primoachlya*.. Revisionary studies on species of *Achlya* and *Thraustotheca* with multiple types of sporangial discharge will have to be conducted to decide the validity of including species which demonstrate achlyoid sporangial discharge, even if only for a limited duration of the asexual cycle, within *Thraustotheca*. Central to the issue is whether primary sporangial type should take precedence over predominance of sporangial type. The dilemma is complex because temperature may influence the relative ratio of each type produced (Alabi, 1972). The current study is foundational for future investigations.

Key to Recognized Species of *Thraustotheca*

1. Sporangia all thraustothecoid, club-shaped; oogonia smooth; antheridia diclinous.......... *T. clavata*

2. Early sporangia achlyoid, later ones thraustothecoid, often more elongate; oogonia with blunt projections; antheridia androgynous............... *T. primoachlya*

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LITERATURE CITED

ALABI, R.O. 1972. Thraustothecoid sporangium formation in three Saprolegniaceae from Nigeria. Trans. Brit. Mycol. Soc. 58: 519-521.

BÜSGEN, M. 1882. Die Entwicklung der Phycomycetensporangien. Jahrb. Wiss. Bot. 13: 253-285.

CLEMENTS, F.E. and C.L. SHEAR. 1931. The Genera of Fungi. The H.W. Wilson Co., New York. iv + 496 p. and 58 plts.

COKER, W.C. 1923. The Saprolegniaceae, with Notes on Other Water Molds. Univ. of North Carolina Press, Chapel Hill. 201p. and 63 plts.

COKER, W.C. 1927. Other water molds from soil. J. Elisha Mitchell Sci. Soc. 42: 207-226.

COKER, W.C. and H.H. BRAXTON. 1926. New water molds from soil. J. Elisha Mitchell Sci. Soc. 42: 139-149.

COKER, W.C. and J.N. COUCH. 1923. A new species of *Thraustotheca*. J. Elisha Mitchell Sci. Soc. 39: 112-114.

COKER, W.C. and J.N. COUCH. 1924. Revision of the genus *Thraustotheca*, with a description of a new species. J. Elisha Mitchell Sci. Soc. 40: 197-201.

COKER, W.C. and O.W. HYMAN. 1912. *Thraustotheca clavata.* Mycologia 4: 87-90.

COKER, W.C. and V.D. MATTHEWS. 1937. Saprolegniales. North America Flora 2: 15-67.

DE BARY, A. 1884. Vergleichende Morphologie und Biologie der Pilze, Mycetozoen und Bacterien. Wilhelm Engelmann, Leipzig. xvi + 558 p.

DE BARY, A. 1888. Species der Saprolegnieen. Bot. Zeit. 46: 597-610, 613-621, 629-636, 645-653. (Paper edited posthumously by H.G. Solms-Laubach.)

DICK, M.W. 1973. Saprolegniales. IN: The Fungi, An Advanced Treatise. Ainsworth, G.C., F.K. Sparrow, and A.S. Sussman, eds. Academic Press, New York and London. pgs. 113-144.

FARR, E.R., J.A. LEUSSINK and F.A. STAFLEU (eds.). 1979. Index Nominum Genericorum (Plantarum), Vol. 3. Reg. Veg. 102: 1277-1896.

FISCHER, A. 1892. Saprolegninae. IN: Rabenhorst's Kryptogamenflora 1(4): 310-383.

GREUTER, W., H.M. BURDET, W.G. CHALONER, V. DEMOULIN, R. GROLLE, D.L. HAWKSWORTH, D.H. NICOLSON, P.C. SILVA, F.A. STAFLEU, E.G. VOSS and J. McNEILL. 1988. International Code of Botanical Nomenclature (ICBN) . Adopted by the Fourteenth International Botanical Congress, Berlin, July-August, 1987. Regnum Vegetabile 118: xiv + 328 p.

HUMPHREY, J.E. 1893. The Saprolegniaceae of the United States, with notes on other species. Trans. Amer. Phil. Soc. (N.S.) 17: 63-148.

INDEX OF FUNGI. 1969. A Supplement to Petrak's Lists. 1920-1939. Commonwealth Mycological Institute, Kew, Surrey. p. 153. (citation source of *T. caucasica*).

JOHNSON, T.W. 1956. The genus *Achlya* : Morphology and Taxonomy. Univ. Michigan Press, Ann Arbor. xv + 180 p.

LANGSAM, D.M. 1986. *Achlya bispora* : A taxonomic reassessment of *Brevilegnia bispora* . Mycologia 78: 600-604.

LANGSAM, D.M. 1987. Notes on the genus *Brevilegnia* : Two exluded taxa. Mycologia 79: 323-324.

SACCARDO, P.A. 1899. Sylloge Fungorum 14: 36.

SALVIN, S.B. 1942. Variations of specific and varietal character induced in an isolate of *Brevilegnia*. Mycologia 34: 38-51.

SCOTT, W.W. 1961. A monograph of the genus *Aphanomyces*. Virginia Agri. Exp. Sta. Tech. Bull. 151: 1-95.

SEYMOUR, R.L. 1970. The genus *Saprolegnia*. Nova Hedwigia 19: iv -124.

SHANOR, L. 1937. Observations on the development and cytology of the sexual organs of *Thraustotheca clavata* (de Bary) Humph. J. Elisha Mitchell Sci. Soc. 53: 119-136.

SPARROW, F.K. 1960. Aquatic Phycomycetes, 2nd. rev. ed. Univ. Michigan Press, Ann Arbor. xxv + 1187 p.

VORONOV, I. 1922. *Thraustotheca caucasica*. Mater. Mikol. Fitopat. Ros. 4(1): 57-58.

WARD, M.W. 1939. Observations on a new species of *Thraustotheca*. J. Elisha Mitchell Sci. Soc. 55: 346-352.

WESTON, W.H. 1918. The development of *Thraustotheca*, a peculiar water-mould. Ann. Bot. 32: 155-173.

WOLF, F.T. 1944. The Aquatic Oomycetes of Wisconsin. Part 1. Univ. Wisconsin Press, Madison. 64 p.

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BIOSTATISTICAL CHARACTERIZATION OF THE GENUS OIDIUM

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A method that takes advantage of biostatistical analysis is proposed for differentiating between species of the genus *Oidium* (anamorph of *Erysiphoideae*), since it is often difficult to distinguish one from the other using the traditional parameters. In addition to the usual parameters, new quantitative morphological parameters are introduced: area, circumference, maximum diameter, shape factor of the circumference, shape factor of the area of the appresoria; true length of conidial foot-cell; area, circumference, shape factor of circumference, shape factor of the area of the conidia. Measurements were made of the anamorphs of various species of *Erysiphaceae* selected from those that have indistinguishable forms according to the traditional measurement methods. The series of values obtained for the single parameters were compared two by two (the values of each sample with the corresponding values of all the others), calculating Student's t for each comparison. The average linkage cluster analysis was then applied, and the relative dendrogram constructed. The latter demonstrates how the anamorphs most similar to one another are found on the plants systematically most like one another, and so on. Apart from demonstrating the possibility to differentiate between anamorphs that would otherwise be indistinguishable, the strict adherence of the conidial form of these obligate pathogens to the relative matrix is also shown. This method is useful both during epidemiological surveys, thus permitting suitable chemical intervention, as well as during systematic investigations on the pathogens under study. The standardization of the method, proposed for the first time in the field of powdery mildews, begins with the considered anamorphs being distributed in a sequence of six-figure codes (given the name "morphotype") expressing the following six groups of characteristics: type of appressoria, conidial shape, placement of conidia, absence or presence of fibrosin bodies, conidial outline, shape of conidiophore foot-cell. The biostatistical analysis described above will successively be applied to the anamorphs of each single morphotype.

Introduction and Aims

As is known, in the subfamily *Erysiphoideae* of the family *Erysiphaceae*, the teleomorphs of the various species can be fairly straightforwardly differentiated. The same cannot be said for the anamorphs (belonging to the genus *Oidium* Link), which, in the light of what is currently known, are often morphologically indistinguishable from each other. Furthermore, the habit of using the name of the teleomorph to indicate the anamorphs as well has more than ever made people refrain from carrying out a close study of the latter. Commenting on the lack of literature on the subject, Braun has recently published a few contributions (1980, 1982, 1982a).

In addition, since several powdery mildews are found, in nature, at the anamorphic state and infrequently, or at least, not always, develop into the perfect form, it has been considered worthwhile to make an accurate investigation of this conidial form.

However, a deeper study of the individual anamorphs is not just an attempt to answer taxonomic queries; the possibility of differentiating one form from another also leads to a more thorough understanding of the epidemiology of the individual species and thus knowing the likelihood, or not, of the mildews on spontaneous plants infecting agricultural crops or spreading among them. The advantages to the planning of control methods are obvious.

The aim of the present work is to reach such results, proposing a methodology based on biostatistical analysis. The analysis is carried out using both classical and new quantitative morphological parameters. The research on new parameters is even more necessary for the anamorphs whose descriptions (when based only on the parameters usually adopted) do not permit exact attribution to one species rather than another.

Materials and Methods

Five samples of "powdery mildews" were selected in the conidial state, according to the following criteria.

As the first criterion, five anamorphs were chosen that, on the basis of the usual characteristics considered in the description of an *Oidium*, presented an identical "profile", i.e.,

- type of appressoria: multi-lobed (type C of Boesewinkel, 1977);
- conidial shape: cylindrical;
- conidial placement: carried singly by the conidiophore (*Pseudoidium*-type anamorph: cfr. Blumer, 1967);
- fibrosin bodies: inconspicuous;
- conidial outline: curvilinear;
- shape of the foot-cells of the conidiophore: cylindrical, flexuous at the base.

Thus, according to the above characteristics, no differentiation exists between the five samples.

As already mentioned, such a criterion was used to select five conidial forms of *Erysiphaceae*, which are cosmopolitan on the following host plants:

1&2) *Erysiphe convolvuli* DC. on two hosts of the same species: *Calystegia sylvatica* (Kit.) Griseb. - Fam. Convolvulaceae, but collected in areas far from one another (this pair is witness to the effectiveness of the proposed method);

3) The same *E. convolvuli* collected on a plant belonging to the family of 1 & 2), but of another genus - *Convolvulus arvensis* L.;

4) Another powdery mildew of a different genus than the preceding one - *Microsphaera trifolii* (Grev.) U. Braun on a host, *Trifolium pratense* L., belonging again to a different family (*Leguminosae*);

5) Another powdery mildew of the same genus as above but belonging to another species - *Microsphaera euonymi-japonici* Viennot-Bourgin, on a host of a family that is very different from the two preceding ones - *Euonymus japonicus* L. fil. (fam. *Celastraceae*).

The identification of the first four conidial forms was confirmed also with the respective teleomorphs.

All five samples were collected on the same day and (obviously with the exception of one of the two *Calystegia*) in the same area, from plants found on the outskirts of Rome that had not undergone any chemical treatments.

The measurements of the individual parameters of the anamorphs under study were statistically processed using a Kontron MOP Videoplan image analyzer connected via a telecamera to a Zeiss photomicroscope.

The quantitative characteristics considered for each sample are relative to the following parameters:

1) area (projection surface) of the appressoria;

2) circumference (projection outline) of the appressoria;

3) maximum diameter (of the projection surface) of the appressoria;

4) shape factor of the circumference of the appressoria, based on the ratio area/circumference (used to define regular or irregular structures: for ellipses and irregular structures its value remains less than 1, while it reaches unity in the case of a circular structure);

5) shape factor of the appressorium area, based on the minimum and maximum area/diameter ratio (as above: in the case of circular structures its value is 1, for irregular structures it remains less than unity);

6) real length of basal cell of the conidiophore;

7) area (projection surface) of conidia;

8) circumference (projection outline) of conidia;

9) shape factor of the conidial circumference (see above);

10) shape factor of the conidial area (see above);

11) conidial length;

12) maximum width of conidia;

13) ratio length/maximum width of conidia.

From a research of the literature, the type of processing reported above has never been previously applied to *Erysiphaceae*, in general.

A broad outline for statistical processing has, at most, been inferred by Zar (1974) and Nordio (1977).

The series of values obtained for the individual parameters (totalling 13 series for each sample) have been compared two by two (the series from each sample with the corresponding series of all the others), calculating Student's $\underline{t}$ for each comparison. In order to visualize the ratio between the above series, the average linkage cluster analysis was applied to the symmetrical matrix of $\underline{t}$, to allow the construction of the relative dendrogram.

Standardization of the Method

As already explained, in order to process the data collected, the preliminary condition was imposed that the anamorphs to be compared belong to the same "profile", based on six characteristics (obviously it is not necessary to differentiate between two or more anamorphs if they already belong to different profiles).

To standardize this sequence of descriptive characteristics, for which the term "morphotype", as used by Ainsworth, 1971, is proposed, it is considered convenient to have a coding.

The morphotype will be characterized by numbers chosen in the six figures, always in the same succession; one then proceeds with the following coding (Fig. according to Boesewinkel (loc. cit) and Braun (1987)).

I-FIGURE Type of appressoria

1. Indistinct: Boesewinkel, fig. 3E, Braun, Fig. 1a.
2. Nipple-shaped: Boesewinkel, fig. 3A, Braun, Fig. 1b-g.
3. Slightly or moderately lobed: Boesewinkel, Fig. 3D, Braun, fig. 1h.
4. Multi-lobed: Boesewinkel, fig. 3C, Braun, Fig. 1i.

II-FIGURE Conidial shape

As is known, conidia of the genus *Oidium* can assume very different shapes, which basically lead back to three:

1. Ellisoid or ovoid: Braun, Figs. 3A and 3B.
2. Cylindric (when the two largest sides are parallel for a long tract: Braun, Fig. 3C).
3. Botuliform or doliform (with nonparallel sides and with the two ends prominent: Braun, Fig. 3D).

III-FIGURE Placement of the conidia

1. Formed singly.
2. Produced in chains.

IV-FIGURE Absence or presence of fibrosin bodies

1. Present - well-developed fibrosin bodies.
2. Absent - inconspicuous fibrosin bodies.

V-FIGURE Conidial outline

1. Curvilinear.
2. Angular, as for the case of *Sawadaea.*

VI-FIGURE Shape of conidiophore foot-cell

This is also very variable but lead back to seven basic morphologies:

1. Gradually decreasing in diameter from base to top: Boesewinkel, Fig. 5E.
2. Cylindrical (straight, cylindrical foot-cell: Boesewinkel, Fig. 5A).
3. Gradually decreasing in diameter from top to base: Boesewinkel, Fig. 5D.
4. Swollen at the base.
5. Moniliform (swollen foot-cell with a conspicuously enlarged basal area: Boesewinkel, Fig. 5B; typical of anamorphs of *Blumeria graminis* (DC.) Speer).
6. Flexuous.
7. Conidiophore curved in the basal half: Braun, Fig. 65c.

As an example of what is listed above, the morphotype under study is: 4 2 1 2 1 6, and so on.

Thus, in order to recognize and differentiate these anamorphs, one first determines the respective morphotypes, grouping together those that are identical. Then, the anamorphs of each morphotype are biostatistically analyzed as described above, with the aim of further differentiating one from the other.

Results

The dendrogram constructed with the processed data is given in Fig. 1. It shows how the measurements that are most similar to one another belong to the two *Erysiphe convolvuli* on the two samples of *Calystegia*. Then, with increasing order of $\underline{t}$, it can be seen that this pair is close to the same *E. convolvuli* collected on the other convolvulacea, but well differentiated from it. The measurements on the powdery mildews of the other two botanical families are considerably dissimilar from the preceding measurements.

Finally, by calculating, for each of the three families under study, the overall average of their Student's $\underline{t}$, we can note how a closer similarity exists between the leguminosa and the three convolvulaceae than between the latter and the celastracea: this is in agreement with the similarity between the botanical families as reported by Hutchinson (1969).

Using the methodology applied here, we can obtain the differentiation of the anamorphs under study, which would be impossible to do by observation only.

Moreover, the biostatistical analysis used on the individual samples leads to a deeper insight into the morphological characterization of the various anamorphs: this information constitutes a valuable databank that can also be used for systematic analyses of the genus *Oidium*.

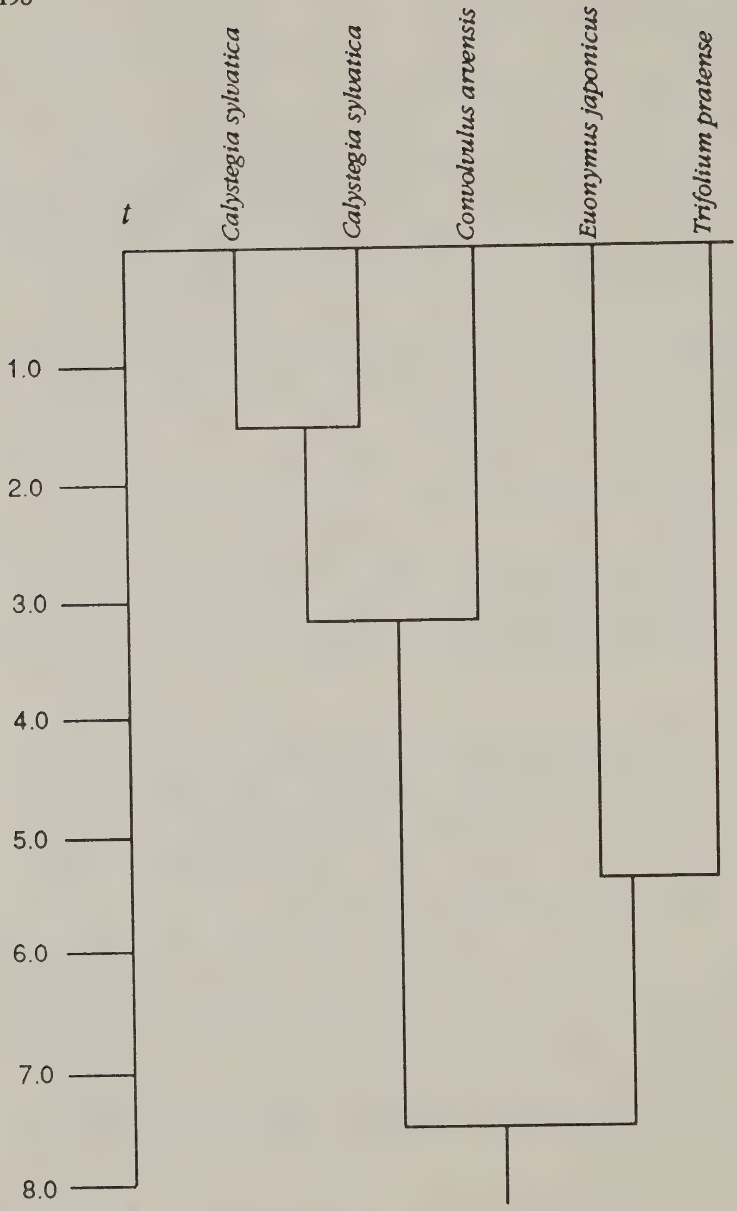
t
Calystegia sylvatica
Calystegia sylvatica
Convolvulus arvensis
Euonymus japonicus
Trifolium pratense
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

Fig. 1 Cluster analysis dendrogram for single linkage applied to the symmetrical matrix of Student's t.

Discussion and Conclusions

The methodology proposed in this work has enabled to distinguish the positions of reciprocal similarity between the five anamorphs examined. The statistical analysis has outlined both a strict adherence of the conidial shape of the pathogen to its host, as well as its precise relationship to the relative teleomorph.

The results confirm the well-known determining influence of the host plants, a true and proper matrix, on at least the anamorphic morphology of the fungus; thus, it can be utilized to investigate the natural distribution of such obligate pathogens.

In the meanwhile the method provides valuable information to enable a deeper insight into the systematics of Erisifaceae.

It can be concluded that, at least in the case of anamorphs, the method presented appears to justify the authors who have proposed a classification of these pathogens that strictly adheres to the taxonomic position in the botanic system of the respective host plants.

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References

Ainsworth, G.C. (1971). Aisnworth & Bisby's Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, 663 pp.

Blumer, S. (1967). Echte Mehltaupilse (*Erysiphaceae*). Gustave Fischer Verlga, Jena, 436, pp.

Boesewinkel, H.J. (1977). Identification of *Erysiphaceae* by conidial characteristics. Revue Mycol., 41: 493-507.

Braun, U. (1980). Morphological studies in the genus *Oidium*. Flora, 170: 77-90.

Braun, U. (1982). Morphological studies in the genus *Oidium* (II). Zbl. Mikrobiol., 137: 138-152.

Braun, U. (1982a). Morphological studies in the genus *Oidium* (III). Zbl. Mikrobiol., 137: 314-324.

Braun, U. (1987). A monograph of the *Erysiphales* (powdery mildews). Nova Hedwigia, beiheft 89. J. Cramer, Berlin-Stuttgart, 1-700.

Hutchinson, J. (1969). Evolution and phylogeny of flowering plants. Academic Press, London and New York, 717 pp.

Nordio, V. (1977). *Festuca alpestris* R. *et* S. nelle prealpi bellunesi. Giorn. Bot. Ital., 111: 123-128.

Zar, J.H. (1974). Biostatistical analysis. Prentice-Hall Inc., Englewood Cliffs, N.J. USA, 620 pp.

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HYPOGEOUS MYCORRHIZAL FUNGI OF SPAIN

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ABSTRACT

Although scientific study of hypogeous fungi in Spain began early in this century, our collections over five years (specially in the northern area of the Iberian Peninsula) produced 18 new species records, including two new species and one new genus. This paper includes first reports in Spain for *Elaphomyces muricatus*, *Glomus macrocarpum*, *Hymenogaster* sp., *Hymenogaster albus*, *H. muticus*, *H. niveus*, *H. tener*, *Hysterangium clathroides*, *H. gardneri*, *Loculotuber gennadi*, *Rhizopogon subareolatus*, *R. ventricisporus*, *Tuber gennadii*, *T. levissimum*, *T. maculatum*, *T. malençonii* and *T. multimaculatum*. Information on previously reported species is expanded to other geographical areas. The updated relation of Spanish hypogeous fungi and its ecological significance in the forests of northern Spain are discussed.

KEY WORDS: Ascomycotina, Basidiomycotina, truffle, ectomycorrhiza, *Elaphomyces*, *Glomus*, *Hymenogaster*, *Hysterangium*, *Loculotuber*, *Rhizopogon*, *Tuber*.

INTRODUCTION

The study of hypogeous fungi in Spain was initiated by Lázaro Ibiza in 1908. The first published compilation of data available on hypogeous fungi in Spain reported 34 species in 12 genera (Calonge et al. 1977). Subsequent additions increased the number of reported fungi considerably (Calonge 1982, Calonge et al. 1985b, Calonge 1990).

Most hypogeous fungi are desirable ectomycorrhizal symbionts of tree seedlings because they increase water and nutrient uptake (Bowen 1973, Luoma et al. 1991). Additional interest for their use in reforestation practices stems from their capability to reduce soil drought stress in tree seedlings (Parke et al. 1983).

To use hypogeous fungi for increasing plantation success, they must be collected in the field, identified, isolated or kept for spore inoculum, and successfully infect seedlings in the nursery (Trappe 1977, Castellano et al. 1985, Castellano and Molina 1989). Many hypogeous ectomycorrhizal fungi show plant-fungus specificity (Molina and Trappe 1982).

Available information on hypogeous fungi in humid northern Spain has been scarce. This area extends from Galicia to Catalonia, a total of ca. 14 million ha. Presently, 4.4 million ha are covered with conifer, broadleaf and mixed forests. An additional 3.3 million ha will be reforested in the future (Anonymous 1989).

The objective of this study was to collect and identify hypogeous mycorrhizal fungi occurring with the major forest species of northern Spain for possible later use in either conventional reforestation, or truffle production programs.

MATERIALS AND METHODS

Fungi were collected at least twice a year from fall through spring of 1985-1989. The Cantabric zone (from Galicia to the west part of the Pyrenees range) was sampled from sea level to 1200 m elevation in a range of forest associations. At the lower elevations (0 - ca 400 m) the stands consisted of either pure *Pinus pinaster* Ait., *Pinus radiata* D. Don or a mixture of the two pines with *Castanea sativa* Mill. At the middle elevations (300 - 700 m) similar mixed forests were examined as also were plantations of *Eucalyptus globulus* Lab. on the coastal slopes. Inland, in the Cantabric range, the tree species were *Acer pseudoplatanus* L., *Corylus avellana* L., *Fraxinus excelsior* L., *Ilex aquifolium* L., *Populus* spp., and *Quercus petraea* (Matts.) Liebl. At the higher elevation (1000 - 1200 m) in Asturias (Picos de Europa) the forests were composed of *Fagus sylvatica* L. and *Quercus pyrenaica* Willd. In Catalonia (Montseny Range) the mixed forests were located at 1000-1200 m elevation and composed of *Abies alba* Mill., *Fagus sylvatica* L., *Quercus ilex* L., *Quercus pubescens* Willd. and plantations of *Picea abies* (L.) Karst. and *Pseudotsuga menziesii* (Mirb.) Franco.

Other areas were occasionally searched for hypogeous fungi. Among them were the Beceite range in southern Catalonia (1200 m elevation in a native *Pinus sylvestris* L. forest) and plantations of introduced pines at the lower elevations of the Montseny Range.

Hypogeous fungi were sought by raking the soil and litter. Care was taken to replace the litter afterwards. Field data were taken on fresh sporocarp features, overstory species composition, associated ectomycorrhizal hosts, and soil characteristics. A few specimens were found with a trained dog. Some collections provided by commercial truffle hunters lacked field data.

Because of their mycological interest, available collections of hypogeous fungi from other areas of Spain recently described have been included in this review (Alvarez et al. 1992). Hypogeous fungi from the Canary Islands were compiled previously by Fogel (1980) and are not included here.

Microscopic observations were made by sectioning sporocarp tissue with a razor blade and mounting the material in water, KOH, cotton blue or Melzer's reagent. Sporocarps were dried at 30°C for herbarium deposit.

Isolations were made from fresh sporocarps on MMN agar slants (Molina and Palmer 1982). Herbarium specimens were deposited in the Instituto Antonio José Cavanilles, Real Jardín Botánico (MA), Madrid, Spain and in the Oregon State University Herbarium (OSC), Corvallis, Oregon. Other herbaria cited are the National Fungus Collections, Washington D.C. (BPI), The Royal Botanic Gardens, Kew (K), and the Istituto ed Orto Botanico, Torino (TO).

RESULTS

A total of 36 species of hypogeous fungi were collected and identified. Eighteen are new records for Spain, including two new species.

The following list attempts to update the known species of hypogeous fungi that occur in Spain. The list includes data on collection site characteristics and associated mycorrhizal hosts when available, as well as the positive results of isolation attempts.

Newly reported species and new localities (provinces) for previously reported species are written in **bold** characters. Collection numbers, place of deposit, and previous references are given in parentheses. An asterisk after the locality indicates that it is an Autonomous Community (composed of one or more provinces) and the exact locality is not known. The symbol (+) after the species name indicates that it was isolated successfully. The identification of the species reported by other authors has not been verified except when indicated.

Balsamia vulgaris Vitt.

BARCELONA, March 1988; 30-40 yr.- old *C. avellana* plantation on dry, stony pH 7.8 soil (MA-28295, OSC), (Calonge et al. 1985b). CORDOBA, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Cistus albidus* L. and *C. avellana*.

Choiromyces magnusii (Matt.) Paol.
EXTREMADURA*, (Calonge et al. 1985a).
Associated mycorrhizal hosts: unknown.

Choiromyces venosus (Fries) Th. Fries (= *C. meandriformis* Vitt., *Tuber sinuosum* Laz.)
ALAVA, (Calonge et al. 1977). BADAJOZ, (Lázaro Ibiza 1908, Moreno et al. 1991). CACERES, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Cistus ladanifer* L., *Fagus* sp., and *Quercus* sp.
NOTE: The type collection of *Tuber sinuosum* Laz. is lost (Calonge et al. 1985a). Lazaro's illustrations and descriptions, however, are readily compatible with *C. venosus*.

Delastria rosea Tul.
BARCELONA, (Calonge et al. 1985b).
Associated mycorrhizal hosts: mixed forest, specific host unknown.

Elaphomyces anthracinus Vitt.
CORDOBA, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Q. ilex*.

Elaphomyces granulatus Fries
ASTURIAS, September 1986; in a *Q. petraea* and *Populus* sp. forest at 760 m. elevation, soil pH:4 (MA-28299, OSC). GIRONA, (Unamuno 1941). PAIS VASCO*, (Calonge et al. 1977). **PONTEVEDRA**, November 1987; under *P. pinaster* on a controlled-burned, flat area. Soil pH: 4.7 (MA-28297, MA-28298, OSC). SEGOVIA, (Calonge et al. 1977). **SORIA**, November 1987; under *P. sylvestris* at 1200 m. elevation. Soil pH: 5.2 (MA-28296, OSC).
Associated mycorrhizal hosts: *F. sylvatica*, *P. sylvestris*, and *Quercus* sp.

Elaphomyces muricatus **Fries**
SANTANDER, May 1986; under *Q. pyrenaica* at 1200 m. elevation (MA-28300, OSC).
Associated mycorrhizal hosts: *Q. pyrenaica*.

Elaphomyces personii Vitt.
GIRONA, (Codina and Font-Quer 1931).
Associated mycorrhizal hosts: *C. sativa*.

Elaphomyces trappei Galán & Moreno
BADAJOZ, (Moreno et al. 1991).
Associated mycorrhizal hosts: *C. ladanifer*.

Gautieria mexicana (Fisch.) Zeller & Dodge
ALAVA, (Calonge et al. 1985b).
Associated mycorrhizal hosts: *P. radiata*.

Gautieria morchelliformis Vitt.
BARCELONA, (Aymerich and Llimona 1986). CORDOBA, (Moreno et al. 1991). CUENCA, (Calonge et al. 1985a). LERIDA, (Calonge et al. 1977).
Associated mycorrhizal hosts: *Abies* sp., *Pinus nigra* Arnold, and *Q. ilex*.

Genea klotzschii Berk. & Broome
BARCELONA, February, March 1988; collected in a 30-40 year-old *C. avellana* plantation on stony, pH 7.8 soil (MA-28301, MA-28302, OSC), (Calonge et al. 1985b). VALLADOLID, (Calonge et al. 1985b).
Associated mycorrhizal hosts: *C. avellana* and *Pinus pinea* L.

Genea verrucosa Vitt.
CORDOBA, (Moreno et al. 1991). TOLEDO, (Arroyo et al. 1989).
Associated mycorrhizal hosts: *C. albidus* and *Q. ilex*.

Geopora arenicola (Lév.) Kers (= *Sepultaria arenicola* (Lév.) Cooke, *S. arenosa* (Fuck.) Cooke)).
GIRONA, (Heim et al. 1934). GRANADA, (Moreno et al. 1986). MADRID, (Moreno et al. 1986). MURCIA, (Honrubia et al. 1983). VALLADOLID, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Pinus* spp., *Pinus halepensis* Mill. and *P. pinaster*.

Geopora cervina (Vel.) Schum.
GRANADA, (Moreno et al. 1986).
Associated mycorrhizal hosts: *Quercus faginea* Lamk. and *Q. ilex*.

Geopora cooperi Harkn.
ALAVA, (Mendaza and Díaz 1987). GRANADA, (Ortega et al. 1981). GUADALAJARA, (Moreno et al. 1986). MADRID, (Moreno et al. 1991). MURCIA, (Honrubia et al. 1990).
Associated mycorrhizal hosts: *Pinus* spp. and *Q. ilex*.

Geopora foliacea (Schaeff.) Ahmad (= *Sepultaria foliacea* (Schaeff.) Boud.)
ALBACETE, (Honrubia et al. 1983). BARCELONA, (Heim et al. 1934). GRANADA, (Ortega et al. 1981). GUADALAJARA, (Moreno et al. 1986). MADRID, (Moreno et al. 1986).
Associated mycorrhizal hosts: *P. halepensis* and *Populus alba* L.

Geopora nicaensis (Boud.) Torre
ALMERIA, (Calonge and Oria de Rueda 1988). BARCELONA, (Losa Quintana 1974, Moreno et al. 1986). GRANADA, (Moreno et al. 1986). GUADALAJARA, (Moreno et al. 1991). MADRID, (Moreno et al. 1986).
Associated mycorrhizal hosts: conifers and *Q. ilex*.

Geopora sumneriana (Cook.) Torre
GRANADA, (Moreno et al. 1986). MADRID, (Moreno et al. 1986).
Associated mycorrhizal hosts: *Cedrus* sp.

Geopora tenuis (Fuck.) Gal.& Ort.
GRANADA, (Galán and Ortega 1982).
Associated mycorrhizal hosts: unknown.

***Glomus macrocarpum* Tul. & Tul.**
ASTURIAS, September 1986; in a mixed forest of *A. pseudoplatanus*, *F. excelsior*, and *Q. petraea* at 700 m. elevation. Soil pH: 4 (MA-28303, OSC).
Associated mycorrhizal hosts: unknown.

Glomus microcarpum Tul. & Tul. (= *Endogone microcarpa* (Tul. & Tul.) Tul.& Tul.
BARCELONA, (Heim et al. 1934).
Associated mycorrhizal hosts: unknown.

Hydnangium aurantiacum Heim & Mal., (= *H. carotaecolor* Berk.)
BARCELONA, (Codina and Font-Quer 1931, Heim et al. 1934).
Associated mycorrhizal hosts: *P. halepensis* and *Q. ilex*.

Hydnangium carneum Wallr.
BADAJOZ, (Moreno et al. 1991). LA CORUÑA, (Jeppson 1987).
Associated mycorrhizal hosts: *Eucalyptus* spp.

Hydnangium pila Pat.
GIRONA, (Heim et al. 1934).
Associated mycorrhizal hosts: *Quercus suber* L.
NOTE: The generic disposition of this species is disputable by modern concepts. Svrcek's designation of it as *Octaviania pila* (Pat.) Svrc. is nomenclaturally unacceptable by International Code of Botanical Nomenclature (Svrcek 1958).

Hydnotrya tulasnei (Berk.) Berk. & Broome
BARCELONA, (Calonge et al. 1985a). VALLADOLID, (Calonge 1982). VIZCAYA, (Mendaza and Díaz 1987).
Associated mycorrhizal hosts: *C. avellana*, *F. sylvatica*, *Pinus* spp. and *Quercus* spp.

***Hymenogaster* sp. No. 1**
GIRONA, November, December 1989; under *P. menziesii* at 1100 m. elevation in pH 5.5 soil (MA-28314, MA-28315, MA-28316, MA-28317, OSC). **PONTEVEDRA**, November 1987; in a 15-yr.-old plantation of *P. menziesii* on flat ground with no understory (MA-28313, OSC).
Associated mycorrhizal hosts: *P. menziesii*.

***Hymenogaster* sp. No. 2**
GIRONA, October 1989; under *P. menziesii* at 1100 m. elevation in pH 5.5 soil (MA-28318, OSC).
Associated mycorrhizal hosts: *P. menziesii*.

***Hymenogaster albus* Berk. & Br.**
ASTURIAS, October 1986; under *E. globulus* at 500 m. elevation (MA-28304, OSC).
Associated mycorrhizal hosts: *E. globulus*.

Hymenogaster bulliardi Vitt.
TOLEDO, (Calonge et al. 1985b).
Associated mycorrhizal hosts: unknown.

Hymenogaster calosporus Tul. & Tul.
BARCELONA, (Heim et al. 1934).
Associated mycorrhizal hosts: *C. avellana*, *Q. ilex* and *Sorbus aucuparia* L.

Hymenogaster cerebellum Cavara
CACERES, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Q. pyrenaica*.

Hymenogaster citrinus Vitt.
ASTURIAS, May 1986; under *Quercus robur* L. at 160 m elevation (MA-28306, OSC). BARCELONA, (Heim et al. 1934). CORDOBA, (Moreno et al. 1991). **GIRONA**, October 1987; under *F. sylvatica* at 1100 m elevation (MA-28305, OSC).
Associated mycorrhizal hosts: *F. sylvatica*, *Q. ilex* and *Q. robur*.

***Hymenogaster muticus* Berk. & Br.**
GIRONA, December 1987; under *P. sylvestris* (MA-28307, OSC).
Associated mycorrhizal hosts: *P. sylvestris*.

Hymenogaster niveus **Vitt.**
SANTANDER, May 1986; under *F. sylvatica* at 1200 m elevation (MA-28308, OSC).
Associated mycorrhizal hosts: *F. sylvatica*.

Hymenogaster olivaceus Vitt.
BARCELONA, (Heim et al. 1934).
Associated mycorrhizal hosts: *C. avellana* and *Q. ilex*.

Hymenogaster populetorum Tul. & Tul.
BARCELONA, (Calonge et al. 1985b).
Associated mycorrhizal hosts: unknown.

Hymenogaster remyi Zeller & Dodge in Dodge & Zeller
GUADALAJARA, (Calonge 1982).
Associated mycorrhizal hosts: *Pinus* sp.

Hymenogaster tener **Berk. & Br.**
ASTURIAS, May 1986; under mixed forest of *E. globulus* and *P. radiata* at 475 m elevation, October 1986; under *F. sylvatica* at 600 m. elevation (MA-28309, MA-28310, OSC).
Associated mycorrhizal hosts: *F. sylvatica*.

Hymenogaster vulgaris Tul.& Tul. in Berk. & Br.
BARCELONA, (Heim et al. 1934, Calonge et al. 1985a).
GIRONA, November, December 1989; under *P. menziesii* at 1100 m. elevation in pH 5.5 soil (MA-28311, MA-28312, OSC).
Associated mycorrhizal hosts: *Pinus* sp. and *P. menziesii*.

Hysterangium clathroides **Vitt.**
ASTURIAS, May 1986; in a 15-years-old *P. radiata* plantation, at 270 m. elevation. (MA-28319, OSC).
Associated mycorrhizal hosts: *P. radiata*.

Hysterangium gardneri **Fischer**
ASTURIAS, May 1986; in a mixed stand of *C. sativa* and *E. globulus* at 575 m. elevation (MA-28320, OSC).
Associated mycorrhizal hosts: *E. globulus*.

Hysterangium rickenii Soehn.
GRANADA, (Moreno et al. 1986).
Associated mycorrhizal hosts: *Q. faginea* and *Q. ilex*.

Hysterangium separabile Zeller
CUENCA, (Calonge et al. 1985a). MADRID, (Calonge et al. 1977).
Associated mycorrhizal hosts: *P. nigra* and *P. sylvestris*.

Hysterangium stoloniferum Tul. var. *rubescens* (Quél.) Zeller & Dodge.
CACERES, (Moreno et al. 1991). CORDOBA, (Moreno et al. 1991).
Associated mycorrhizal hosts: *C. sativa* and *Q. ilex*.

Hysterangium thwaitesii Berk. & Broome
ALAVA, (Calonge et al. 1977).
Associated mycorrhizal hosts: unknown.

Labyrinthomyces donkii Mal.
ALICANTE, (Honrubia 1984). CADIZ, (Calonge 1982, 1983). MURCIA, (Honrubia 1984).
Associated mycorrhizal hosts: *E. globulus.*
NOTE: This genus has been recently revised by Trappe et al. (1992).

Leucogaster floccosus Hesse
MURCIA, (Honrubia and Llimona 1981).
Associated mycorrhizal hosts: unknown.

Loculotuber gennadi **Trappe, Parladé & Alvarez**
CACERES, May 1987; (MA-26771, OSC). (Alvarez et al. 1992).
Associated mycorrhizal hosts: unknown.

Martellia mediterranea Moreno, Galán & Montecchi
CACERES, (Moreno et al. 1991).
Associated mycorrhizal hosts: *C. ladanifer* and *Q. ilex.*

Melanogaster ambiguus (Vitt.) Tul. (+).
BARCELONA, (Calonge 1982). GIRONA, November 1989 and June 1990 under *P. menziesii* at 1100 m. elevation in pH 5 soil (MA-28321, MA-28322, MA-28323, MA-28324, MA-28325, OSC), (Martín 1988). MADRID, (Moreno et al. 1986).
Associated mycorrhizal hosts: *F. sylvatica, P. menziesii, Q. ilex*, and *Q. suber.*

Melanogaster broomeianus Berk. in Tul. & Tul
ALBACETE, (Calonge and Demoulin 1975). BARCELONA, (Calonge et al. 1985b, Llistosella and Aguasca 1986). GIRONA, (Maire 1937, Singer 1947). MADRID, (Calonge et al. 1985a).
Associated mycorrhizal hosts: *P. sylvestris* and *P. pinea.*

Melanogaster variegatus (Vitt.) Tul. & Tul.
ALBACETE, (Calonge 1973). CACERES, (Moreno et al. 1991). CORDOBA, (Moreno et al. 1991). GUIPUZCOA, (Lazaro Ibiza 1912). MURCIA, (Honrubia et al. 1990). VALENCIA, (Lazaro Ibiza 1912).
Associated mycorrhizal hosts: *Pinus spp.* and *Q. suber.*

Octaviania asterosperma Vitt.
CACERES, (Moreno et al. 1991).

Picoa juniperi Vitt.
MADRID, (Calonge et al. 1985a). ZARAGOZA, (Calonge 1982).
Associated mycorrhizal hosts: unknown.

Rhizopogon luteolus Fries & Nordh. (+)
ALAVA, December 1989; under *P. sylvestris* (MA-28326, OSC). **ASTURIAS**, October 1986; under *P. radiata* at 100 m. elevation (MA-28327). BARCELONA, (Maire et al 1933, Heim et al. 1934, Llimona 1984, Martín 1988). GIRONA, (Maire et al. 1933, Llimona 1983, Martín 1988). LERIDA, (Maire 1937). MADRID, (Calonge and Zugaza 1973, Calonge and Demoulin 1975). **PONTEVEDRA**, November 1985, 1986, and 1987; under *P. pinaster* in compacted, sandy pH 4.7-6 soils and sometimes abundant in controlled-burned areas (MA-28328 MA-28329 MA-28330, MA-28331, MA-28332, MA-28333, MA-28334, MA-28335, MA-28336, OSC). TARRAGONA, (Maire 1937).
Associated mycorrhizal hosts: *P. nigra, P. pinaster, P. pinea, P. radiata* and *P. sylvestris.*

Rhizopogon roseolus (Corda ex Sturm) Th. Fries (= *R. aestivus* (Tul. & Tul.) Tul. & Tul., *R. rubescens* Tul & Tul.) (+)
ALBACETE, (Honrubia et al. 1982). ALICANTE, (Honrubia et al. 1982). ALMERIA, (Honrubia et al. 1982). **ASTURIAS**, December 1985, May and October 1986; under *P. radiata* plantations at 100-350 m. elevation in pH 5.1 soil (MA-28337 and MA-28338, OSC). BALEARES, (Malençon and Bertault 1972). BARCELONA, (Codina and Font-Quer 1931, Maire et al. 1933, Heim et al. 1934, Maublanc 1936, Singer 1947, Calonge and Demoulin 1975, Tabares and Rocabruna 1987, Martín 1988). GIRONA, (Maire et al. 1933, Maire 1937, Font-Quer 1954, Calonge and Demoulin 1975, Llimona 1983, Martín 1988). JAEN, (Honrubia et al. 1982). **LEON**, November 1989; under *P. sylvestris* in sandy soil (MA-28342, MA-28343, OSC). LERIDA, (Calonge and Demoulin 1975, Llimona 1983, Martín 1988). MADRID, (Calonge 1973, Calonge and Zugaza 1973, Calonge and Demoulin 1975). MALAGA, (Calonge and Demoulin 1975). MURCIA, (Honrubia et al. 1982). **PONTEVEDRA**, November 1986; under *P. pinaster* (MA-28339, OSC). **TARRAGONA**, September 1987, August 1989; under *P. sylvestris* at 1100 m. elevation in pH 7.4 soil (MA-28340, MA-28341, OSC). VALLADOLID, (Calonge and Demoulin 1975).
Associated mycorrhizal hosts: *P. halepensis*, *Pinus mugo* Turra., *P. nigra*, *P. pinaster*, *P. pinea*, *P. radiata* and *P. sylvestris*.

Rhizopogon subareolatus Smith (+)
GIRONA, November, December 1987 and 1988, abundant under *P. menziesii* plantations or under *Abies* sp. with *P. menziesii* present on slopes at 1100 m. altitude in pH 4.7-6 soil (MA-28344, MA-28345, MA-28346, MA-28347, MA-28348, MA-28349, MA-28350, and MA-28351, OSC).
Associated mycorrhizal hosts: *P. menziesii*.
NOTE: This species has not previously been reported in continental Europe. It was reported in the Madeira islands where it was probably introduced with *P. menziesii* (Fogel 1980).

Rhizopogon ventricisporus Smith (+)
TARRAGONA, September 1987; under *P. sylvestris* at 1100 m. elevation in pH 7.4 soil (MA-28352, OSC).
Associated mycorrhizal hosts: *P. sylvestris*.

Rhizopogon vulgaris (Vitt.) M. Lange (= *R. provincialis* Tul. & Tul.) (+)
ALBACETE, (Honrubia et al. 1982). **ASTURIAS**, May 1986 and October 1986; under *P. radiata* at 100-350 m elevation in pH 5.1 soil (MA-28353, MA-28354, MA-28355 and MA-28356, OSC). BARCELONA, (Codina and Font-Quer 1931, Martín 1988). GIRONA, (Heim et al. 1934, Malençon and Bertault 1971). MADRID, (Calonge and Demoulin 1975). MALAGA, (Calonge and Demoulin 1975). **PONTEVEDRA**, November 1985, 1986 and 1987; under *P. pinaster* on coast in pH 4.7 soil in controlled-burned areas and under *P. menziesii* in 15 year-old plantations (MA-28357, MA-28358, MA-28359, MA-28360 and MA-28361, OSC). **SORIA**, November 1987; under *P. sylvestris* at 1200 m elevation in pH 5.2 soil (MA-28362 and MA-28363, OSC).
Associated mycorrhizal hosts: *P. halepensis*, *P. nigra*, *P. pinaster*, *P. radiata*, *P. sylvestris* and *P. menziesii*.

Terfezia arenaria (Mor.) Trappe (= *T. leonis* Tul.)
BADAJOZ, (Calonge et al. 1977, Calonge et al. 1985a). CACERES, May 1987 (MA-28364 and MA-28365, OSC), (Moreno et al. 1986). HUELVA, (Calonge et al. 1985a). TOLEDO, (Calonge et al. 1985b).
Associated mycorrhizal hosts: *C. ladanifer*, *Cistus monspeliensis* L., *Cistus salvifolius* L. and *Helianthemum guttatum* Mill.

Terfezia berberiodora (Lesp. ex Tul. & Tul.) Tul. & Tul.
LA CORUÑA, (Castro and Freire 1982).
Associated mycorrhizal hosts: unknown.

Terfezia claveryi Chat.
BURGOS, (Calonge et al. 1985b). GRANADA, (Calonge et al. 1985b, Moreno et al. 1986). MADRID, (Calonge et al. 1985b).
Associated mycorrhizal hosts: *Helianthemum salicifolium* Pers.

Terfezia hispanica Laz.
ALBACETE, (Lázaro Ibiza 1908). BADAJOZ, (Lázaro Ibiza 1908). CACERES, (Lázaro Ibiza 1908). CIUDAD REAL, (Lázaro Ibiza 1908). CORDOBA, (Lázaro Ibiza 1908). GRANADA, (Lázaro Ibiza 1908). GUADALAJARA, (Lázaro Ibiza 1908). MADRID, (Lázaro Ibiza 1908). SALAMANCA, (Lázaro Ibiza 1908). TOLEDO, (Lázaro Ibiza 1908). ZARAGOZA, (Lázaro Ibiza 1908).
Associated mycorrhizal hosts: *Helianthemum paniculatum* Durm., *H. salicifolium*, *Helianthemum vulgaris* Gaertn., and *Tuberaria variabilis* Wk.
NOTE: *T. hispanica* may be an aberrant collection of *T. olbiensis*; the type collection is lost (Calonge et al. 1985a). Because of its distinctive vinaceous color as illustrated by Lázaro Ibiza (1908), however, we prefer to keep it separate from *T. olbiensis* pending new collections.

Terfezia olbiensis (Tul. & Tul.) Tul. & Tul. (= *T. leptoderma* (Tul. & Tul.) Tul. & Tul., *T. cadevalli* Font-Quer, *Tuber lutescens* Laz., *T. pallidum* Laz.)
ALAVA, (Calonge et al. 1977). ALBACETE, (Lázaro Ibiza 1908). AVILA, (Lázaro Ibiza 1908). BADAJOZ, (Calonge et al. 1977, Calonge et al. 1985b). BARCELONA, (Codina and Font-Quer 1931). BURGOS, (Calonge et al. 1985b). CACERES, May 1987 (MA-28366 and MA-28367, OSC), (Moreno et al. 1986). CIUDAD REAL, (Lázaro Ibiza 1908). MADRID, (Lázaro Ibiza 1908, Calonge 1982, Calonge et al. 1985b). SALAMANCA, (Lázaro Ibiza 1908). SEGOVIA, (Calonge et al. 1985b). TOLEDO, (Calonge et al. 1985b). VALLADOLID, (Lázaro Ibiza 1908). ZAMORA, (Lázaro Ibiza 1908).
Associated mycorrhizal hosts: *H. guttatum*, *H. paniculatum*, *Q. ilex*, and *T. variabilis*.
NOTE : We have found many sporocarps intermediate in morphology between those reported for *T. olbiensis* and *T. leptoderma* in the numerous collections we have examined. Most differences appear to be a matter of developmental stage, as indicated by Fogel (1980). Hence, we regard *T. leptoderma* as a synonym of *T. olbiensis* (we choose *T. olbiensis* as the epithet to retain, because its type collection contains more mature material than does that of *T. leptoderma*). Although the type collections of *Terfezia cadevalli* Font-Quer, *Tuber lutescens* Laz. and *T. pallidum* Laz. are lost (Calonge et al., 1985a), the descriptions of each present no reason to regard them other than as somewhat inmature to mature stages of *T. olbiensis*.

Trappea darkeri (Zeller) Castellano
GUADALAJARA, (Calonge 1982).
Associated mycorrhizal hosts: *Pinus* sp.
NOTE: This collection was initially reported as *Hysterangium membranaceum* Vitt. (Castellano 1990).

Tuber aestivum Vitt.
BARCELONA, March 1987 (MA-28368, OSC), (Unamuno 1941, Calonge et al. 1985a). CORDOBA, (Moreno et al. 1991). GIRONA, (Codina and Font-Quer 1931, Unamuno 1941). **LERIDA**, March 1987; under *Pinus* sp. (MA-28369, OSC). **TERUEL**, March 1987; under *Pinus* sp. (MA-28370, OSC).
Associated mycorrhizal hosts: *C. avellana*, *Pinus* sp. and *Q. ilex*.

Tuber asa Tul. & Tul.
BADAJOZ, (Moreno et al. 1991). CACERES, May 1987, (MA-28371 and MA-28372, OSC), (Moreno et al. 1991).
Associated mycorrhizal hosts: *C. ladanifer*.

Tuber borchii Vitt.
MURCIA, (Honrubia and Llimona 1981).
Associated mycorrhizal hosts: *P. halepensis*.

Tuber brumale Vitt.
BARCELONA, March 1988; under *C. avellana* in 30-40 year-old plantations in pH 7.8 soil (MA-28373, OSC), (Codina and Font-Quer 1931), and three collections at TO. CASTELLON, (Calonge et al. 1977). GIRONA, (Lázaro Ibiza 1912, Codina and Font-Quer 1931, Heim et al. 1934, Unamuno 1941). GUADALAJARA, (Calonge et al. 1977). MADRID, one collection at TO. **TARRAGONA**, March 1987 (MA-28374, OSC).
Associated mycorrhizal hosts: *C. avellana* and *Quercus* sp.

Tuber excavatum Vitt.
BARCELONA, (Calonge et al. 1985a, b). CORDOBA, (Moreno et al. 1991). **GUADALAJARA**, December 1987, under *Populus* sp. at 1100 m. altitude (MA-28375, OSC).
Associated mycorrhizal hosts: *C. avellana*, *Pinus* sp., *Populus* sp. and *Q. ilex*.

Tuber foetidum Vitt.
BALEARES, (Calonge 1982, 1983). BARCELONA, (Calonge et al. 1985b).
Associated mycorrhizal hosts: *Pinus* sp.

***Tuber gennadii* (Chat.) Pat.**
CACERES, May 1987 (MA-28376, OSC).
Associated mycorrhizal hosts: unknown.

***Tuber levissimum* Gilkey**
GIRONA, November 1989, December 1989, and June 1990; under *P. menziesii* in pH 5.5 soil (MA-28377, MA-28378, MA-28379, MA-28380, OSC).
Associated mycorrhizal hosts: *P. menziesii*.

***Tuber maculatum* Vitt.**
GIRONA, October, December 1989; under *P. menziesii* in pH 5.5 soil (MA-28381, MA-28382, OSC).
Associated mycorrhizal hosts: *P. menziesii*.

***Tuber malençoni* Don., Riouss. & Chev.**
BARCELONA, March 1987 (MA-28385, OSC). **LERIDA**, March 1987 (MA-28384, OSC). **TERUEL**, March 1987 (MA-28383, OSC).
Associated mycorrhizal hosts: unknown.

Tuber maresa Font-Quer
GIRONA, (Codina and Font-Quer 1931).
Associated mycorrhizal hosts: unknown.
NOTE: *T. maresa* seems likely to be an immature collection of *T. mesentericum*, but we have not located the holotype for study.

Tuber melanosporum Vitt.
BARCELONA, (Unamuno 1941), one collection at BPI (Lloyd 22118) plus five collections at TO. GIRONA, (Lázaro Ibiza 1912, Codina and Font-Quer 1931, Heim et al. 1934).

GUADALAJARA, December 1987, under *Q. ilex* at 1200 m. altitude (MA-28390, OSC), (Calonge et al. 1985b, Moreno et al. 1986). **HUESCA**, December 1987; under *Q. ilex* (MA-28386, MA-28387, MA-28388, MA-28391, OSC). **TARRAGONA**, February - March 1987; under *C. sativa* (MA-28392 and MA-28393, OSC). **TERUEL**, March, 1987 (MA-28389, OSC).
Associated mycorrhizal hosts: *C. sativa*, *C. avellana*, and *Q. ilex*.

Tuber mesentericum Vitt.
BARCELONA, (Unamuno 1941). **TARRAGONA**, March 1987; under *C. sativa* (MA-28394, OSC). TERUEL, (Calonge 1983).
Associated mycorrhizal hosts: *C. sativa*.

***Tuber multimaculatum* Parladé, Trappe & Alvarez**
TARRAGONA, March 1987; (MA-26769, MA-26770, OSC). (Alvarez et al. 1992).
Associated mycorrhizal hosts: unknown.

Tuber nitidum Vitt.
CORDOBA, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Q. ilex*.

Tuber oligospermum (Tul. & Tul.) Trappe (= *Terfezia oligosperma* Tul. & Tul.)
LA CORUÑA, (Castro and Freire 1982).
Associated mycorrhizal hosts: unknown.

Tuber panniferum Tul. & Tul
CORDOBA, (Moreno et al. 1991).
Associated mycorrhizal hosts: *Q. ilex*.

Tuber puberulum Berk. & Broome
BARCELONA, (Heim et al. 1934).
Associated mycorrhizal hosts: *Q. ilex*.

Tuber rufum Pico:Fries (= *Tuber ferrugineum* Vitt.)
BARCELONA, March 1988; in a 30-40 yr.-old *C. avellana* plantation in a stony pH 7.8 soil (MA-28396, OSC), (Calonge et al. 1985a, b; Moreno et al. 1991). CACERES, (Moreno et al. 1991). CASTELLON, (Calonge et al. 1977). CUENCA, (Calonge et al. 1977). **GIRONA**, November, December 1989; under *P. menziesii* in Ph 5.5 soil (MA-28395, MA-28397, OSC). MALAGA, one collection at K.
Associated mycorrhizal hosts: *C. sativa*, *C. avellana*, *Pinus* sp., *Q. faginea*, and *Q. ilex*.

DISCUSSION

Throughout five years of field sampling in forests of northern Spain, we observed that hypogeous fungi are scarce and difficult to find. Only species of the genus *Rhizopogon* were obtained with relative ease every fall and spring, once the field sites where they occur had been identified. The finds of two new taxa of hypogeous Pezizales (Tuberales) and new records of others indicate that systematic research is needed in many areas of Spain to complete the list of hypogeous mycoflora.

Animal digging (holes, channels or scraped soil) was observed in mild coastal areas of Asturias and Galicia and in mountains of Catalonia. Animal activity of this sort was not observed at other places where hypogeous fungi were collected. The interrelationship between mycophagous small mammals and hypogeous fungi has been proven in North America (Fogel and Trappe 1978, Maser et al. 1978, Ure and Maser 1982) and in Australia (Malajczuk et al. 1987). Also, wild boars and foxes readily penetrate commercial plantations of *Tuber melanosporum* protected with electric fences in search of sporocarps. The relationship between animal vectors and hypogeous fungi has not been studied in Spain, although Durrieu et al. (1984) report substantial utilization by small mammals in the French Pyrenees. The scarcity of sporocarps observed in many Spanish forests may be because of the low number of species, or low populations of animal vectors thus reducing spore dissemination of fungi already present in the forests.

Many genera of hypogeous fungi, both Ascomycetes and Basidiomycetes, have never been found in Spain. This may indicate lack of long term studies on the hypogeous mycoflora of Spanish forests. Hunt and Trappe (1987) indicate that documenting all species of hypogeous ectomycorrhizal fungi in a forest stand requires long-term collecting over several years. The production of sporocarps varies from year to year (Fogel 1976) and hypogeous fungal species are scarce when compared to epigeous species in stands of conifers (Luoma et al. 1991). The relatively low diversity of tree species (particularly conifers) in Spanish forests compared with that in places such as the American Northwest, where hypogeous fungi abound, could also explain in part the low species diversity of hypogeous fungi in Spain.

Northern Spain has residual virgin forests, but most extensive forests are the result of human reforestation, often with species native to other continents such as *Pinus radiata*, *P. lambertiana*, *Pseudotsuga menziesii*, and *Eucalyptus* spp. Research programs to introduce exotic forest species into Europe are likely to continue, given the poverty of indigenous genetic material available (CEE 1984). Hence, parallel research on the hypogeous mycorrhizal symbionts of forest tree species in their area of origin and on the native hypogeous fungi in the introduction area is desirable to assess the need of introducing a particular fungal symbiont for successful establishment of the trees. In some Spanish plantations of *P. menziesii*, the host-specific hypogeous mycorrhizal fungi *Rhizopogon subareolatus* has been collected consistently and was probably introduced with its host seedlings long ago.

Isolations from sporocarps were obtained with relative ease only from the *Rhizopogon* species. Some species such as *R. roseolus*, were collected in both acid (pH 5) and slightly basic (pH 7.4) soils. This genetic diversity is an important consideration in selecting fungal candidates for use in nursery inoculations (Trappe 1977). Knowledge of the adaptability and host range of the fungal symbiont as well as the receptivity and infectivity of the planting site are important in evaluating the success of introduced fungi in improving forestry practices.

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LITERATURE CITED

Alvarez, I.F., J. Parladé and J.M. Trappe. 1992. *Loculotuber gennadii* gen. & comb. nov. and *Tuber multimaculatum* sp. nov. (Tuberaceae). **Mycologia 84:926-929.**

Anonymous. 1989. Anuario de Estadística Agraria. **Minist. Agric. Pesca Aliment. Madrid. 678 pp.**

Arroyo, I., F.D. Calonge, G. Carrascosa and E. Sau. 1989. Nuovi funghi ipogei di Spagna III. *Hydnocystis clausa* (Tul.) Ceruti e *Genea verrucosa* Vitt. **Micol. Ital. 1:3-7.**

Aymerich, J. and X. Llimona. 1986. *Gautieria morchellaeformis* Vitt. (Gastrosporiales, Gasteromicetes) al Berguedà (Catalunya). **Folia Bot. Misc. 5:145.**

Bowen, G.D. 1973. Mineral nutrition of ectomycorrhizae. In **Ectomycorhizae. Their ecology and physiology**. Edited by **G.C. Marks and T.T. Kozlowski. Academic Press, New York. pp. 151-205.**

Calonge, F.D. 1973. Estudios sobre hongos. IV. Aportación al catálogo de las provincias de Madrid y Sevilla. **An. Inst. Bot. Cavanilles 30:19-32.**

Calonge, F.D. 1982. Adiciones al catálogo de hongos hipogeos de España. **García de Orta Ser. Estud. Agron. 9:143-146.**

Calonge, F.D. 1983. Algunos hongos raros o nuevos para España. **Lazaroa 5:283-289.**

Calonge, F.D. 1990. Check-list of the Spanish Gasteromycetes (*Fungi, Basidiomycotina*). **Crypt. Bot. 2:33-55.**

Calonge, F.D. and V. Demoulin. 1975. Les Gasteromycetes d'Espagne. **Bull. Soc. Mycol. Fr. 91:247-292.**

Calonge, F.D. and J.A. Oria de Rueda. 1988. Aportación a la micoflora de la provincia de Almería. **Bol. Soc. Micol. Cast. 12:93-106.**

Calonge, F.D. and A. Zugaza. 1973. Catálogo de los hongos presentados en la I exposición de Madrid, del 1 al 5 de Noviembre de 1972. **An. Inst. Bot. Cavanilles 30:33-55.**

Calonge, F.D., A. Rocabruna and M. Tabarés. 1985a. Nuevos datos sobre los hongos hipogeos de España. **Bol. Soc. Micol. Cast. 9:45-54.**

Calonge, F.D., A. Rocabruna, M. Tabarés and N.B. Rodriguez. 1985b. Nuevos datos sobre los hongos hipogeos de España. II. Géneros *Balsamia*, *Delastria* y *Genea*, novedades para el catálogo español. **Butll. Soc. Cat. Micol. 9:57-64.**

Calonge, F.D., M. de la Torre and M. Lawrynowicz. 1977. Contribución al estudio de los hongos hipogeos de España. **An. Inst. Bot. Cavanilles 34:15-31.**

Castellano, M.A. 1990. The new genus *Trappea* (Basidiomycotina, Hysterangiaceae), a segregate from *Hysterangium*. **Mycotaxon 38:1-9.**

Castellano, M.A. and R. Molina. 1989. Mycorrhizae. In: **The container tree nursery manual, Vol. 5, Handbk. 674.** Edited by **T.D. Landis, R.W. Tinus, S.E. McDonald and J.P. Barrett. U.S.D.A. For. Serv., Washington, D.C.** pp. 101-167.

Castellano, M.A., J.M. Trappe and R. Molina. 1985. Inoculation of container-grown Douglas-fir with basidiospores of *Rhizopogon vinicolor* and *R. colossus*: effects of fertility and spore application rate. **Can. J. For. Res.** 15:10-13.

Castro, M.L. and L. Freire. 1982. *Terfezia berberiodora* y *T. oligosperma* encontradas en Galicia, nuevas para España. **Collect. Bot. (Barc.) 13:441-444.**

CEE. 1984. L'Europe verte. La Couverture verte de L'Europe. Nos fôrets d'aujourd'hui et de demain. **Brussels. 24 pp.**

Codina, J. and P. Font-Quer. 1931. Introducció a l'estudi dels macromicets de Catalunya. **Cavanillesia 3:100-189.**

Durrieu, G., M. Genard and F. Lescourret. 1984. Les micromammifères et la symbiose mycorrhizienne dans une forêt de montagne. **Bul. Ecol. 15:253-263.**

Fogel, R. 1976. Ecological studies of hypogeous fungi. II. Sporocarp phenology in a western Oregon Douglas-fir stand. **Can. J. Bot. 54:1152-1162.**

Fogel, R. 1980. Additions to the hypogeous mycoflora of the Canary Islands and Madeira. **Contr. Univ. Mich. Herb. 14:75-82.**

Fogel, R. and J.M. Trappe. 1978. Fungus consumption (mycophagy) by small mammals. **Northwest Sci. 52:1-31.**

Font-Quer, P. 1954. Plantas de Greixa (Pirineo catalán). **Collect. Bot. (Barc.) 4:173-177.**

Galán, R. and A. Ortega. 1982. *Geopora tenuis* (Fuckel) Galán & Ortega comb. nov., nuevo pezizal para la micoflora española. **Bol. Soc. Micol. Cast. 7:49-51.**

Heim, R., P. Font-Quer and J. Codina. 1934. Fungi Iberici. Observations sur la flore mycologique catalane. **Treb. Mus. Cienc. Nat. Barc, Ser. Bot. 15, 146 pp.**

Honrubia, M. 1984. *Labyrinthomyces donkii* Malençon, en el S.E. de España. **Int. J. Mycol. Lichenol. 1:345-349.**

Honrubia, M. and X. Llimona. 1981. Aportación al conocimiento de los hongos del S.E. de España. IV. Tres citas nuevas para la microflora española. *Pustularia insignis*, *Tuber borchii*, *Leucogaster* cf. *floccosus*. **An. Univ. Murcia Cienc. 37:81-90.**

Honrubia, M., P. Berthet and X. Llimona. 1983. Contribution a la connaissance des champignons du sud-est de l'Espagne. VII. Pezizales (Ascomycetes). **Bull. Soc. Linn. Lyon 52:46-62.**

Honrubia, M., F.D. Calonge, V. Demoulin, G. Moreno and X. Llimona. 1982. Aportación al conocimiento de los hongos del S.E. de España VI: Esclerodermatales, Licoperdales, Nidulariales, Falales, Himenogasterales, Podaxales (Gasteromicetes, Basidiomicetes). **An. Univ. Murcia Cienc.** 38:101-132.

Honrubia, M., A. Cano and C. Molina-Niñirola. 1990. Nota sobre hongos hipogeos del semiárido murciano. Resúmenes V Reunión Conjunta de Micología. **Rev. Iberoamericana Micol. 7:95.**

Hunt, G.A. and J.M. Trappe. 1987. Seasonal hypogeous sporocarp production in a western Oregon Douglas-fir stand. **Can. J. Bot. 65:438-445.**

Jeppson, M. 1987. Notes on some Spanish Gasteromycetes. **Bol. Soc. Micol. Madr. 11:267-282.**

Lazaro Ibiza, B. 1908. Nuevos Tuberáceos de España. **Rev. R. Acad. Cienc. Exactas Fis. Nat. Madr. 6:801-826.**

Lazaro Ibiza, B. 1912. Notas micológicas. Colección de datos referentes a los hongos de España. 3ª serie. **Mem. R. Soc. Esp. Hist. Nat. 7:287-341.**

Llimona, X. 1983. Sobre fongs de primavera a Catalunya. **Butll. Soc. Cat. Micol. 7:33-45.**

Llimona, X. 1984. Llista d'espécies de l'exposició de fongs organitzada a Barcelona l'octubre de 1977. **Butll. Soc. Cat. Micol. 8:39-46.**

Llistosella, J. and M. Aguasca. 1986. El 1er mini foray de la British Mycological Society a Catalunya. **Butll. Soc. Cat. Micol. 10:19-33.**

Losa Quintana, J.M. 1974. Contribución al conocimiento de los Ascomycetes con apotecios de Cataluña. **Collect. Bot. (Barc.) 9:45-60.**

Luoma, D.L., R.E. Frenkel, and J.M. Trappe. 1991. Fruiting of hypogeous fungi in Oregon Douglas-fir forests: seasonal and habitat variation. **Mycologia 83: 335-353.**

Maire, R. 1937. Fungi Catalaunici. Series Altera. Contribution a l'étude de la Flore Mycologique de la Catalogne. **Publ. Inst. Bot. Barc. 3, 128 pp.**

Maire, R., J. Codina and P. Font-Quer. 1933. Fungi Catalaunici. Serie Botànica. Contributions à l'étude de la Flore Mycologique de la Catalogne. **Publ. Mus. Cienc. Nat. Barc. 15:1-120.**

Malajczuk, N., J.M. Trappe and R. Molina. 1987. Interrelationships among some ectomycorrhizal trees, hypogeous fungi and small mammals. Western Australian and northwestern American parallels. **Aust. J. Ecol. 12:53-55.**

Malençon, G. and R. Bertault. 1971. Champignons de la Peninsule Ibérique. I. Explorations entre le Midi valencien et le Montseny. **Acta Phytotaxon. Barc. 8:1-68.**

Malençon, G. and R. Bertault. 1972. Champignons de la Peninsule Ibérique. IV. Les Iles Baléares. **Acta Phytotaxon. Barc. 11:1-64.**

Martin, M.P. 1988. Aportación al conocimiento de las higroforáceas y los gasteromicetos de Cataluña. **Edic. Esp. Soc. Cat. Micol. 2. 508 pp.**

Maser, C., J.M. Trappe and R.A. Nussbaum. 1978. Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. **Ecology 59:799-809.**

Maublanc, M.A. 1936. Rapport sur la session générale de la Societé Mycologique de France, tennue a Barcelone de 19 a 27 octubre 1935. **Bull. Soc. Mycol. Fr. 52:17-32.**

Mendaza, R. and G. Díaz. 1987. Las setas. **Ed. Iberduero, Vizcaya. 932 pp.**

Molina, R. and J.G. Palmer. 1982. Isolation, maintenance, and pure culture manipulation of ectomycorrhizal fungi. In: **Methods and principles of mycorrhizal research**. Edited by **N.C. Schenck. Amer. Phytopathol. Soc., St. Paul, MN. pp. 115-129.**

Molina, R. and J.M. Trappe. 1982. Patterns of ectomycorrhizal host specificity and potential among Pacific Northwest conifers and fungi. **For. Sci. 28:423-458.**

Moreno, G., R. Galan and A. Ortega. 1986. Hypogeous fungi from continental Spain. I. **Cryptogam. Mycol. 7:201-229.**

Moreno, G., R. Galan and A. Montecchi. 1991. Hypogeous fungi from peninsular Spain. **Mycotaxon 42:201-238.**

Ortega, A., R. Galán and M. de la Torre. 1981. Aportación al estudio de los hongos de Andalucía. IV. El Orden Pezizales en la provincia de Granada. **Bol. Soc. Micol. Cast. 6:39-50.**

Parke, J.L., R.G. Linderman and C.H. Black. 1983. The role of ectomycorrhizas in drought tolerance of Douglas-fir seedlings. **New Phytol. 95:83-95.**

Singer, R. 1947. Champignons de la Catalogne. Espéces observées en 1934. **Collect. Bot. (Barc.) 1:199-246**

Svrcek, M. 1958. III. Rád Hymenogastrales - Hlizotvaré. *In*: **A. Pilát, Flora CSR, Gasteromycetes. Práce Cesk. Akad. Véd, Prague. pp. 121-208.**

Tabares, M. and A. Rocabruna. 1987. Aportación al conocimiento de los hongos de la sierra de Collcerola (Catalunya). **Butll. Soc. Cat. Micol. 11:83-98.**

Trappe, J.M. 1977. Selection of fungi for ectomycorrhizal inoculation in nurseries. **Annu. Rev. Phytopathol. 15:203-222.**

Trappe, J.M., M.A. Castellano and N. Malajczuk. 1992. *Labyrinthomyces*, *Dingleya* and *Reddellomyces* gen. nov. (Ascomycotina). **Aust. Syst. Bot. 5:597-611.**

Unamuno, L.M.. 1941. Enumeración y distribución geográfica de los Ascomycetes de la Península Ibérica y de las Islas Baleares. **Mem. R. Acad. Cienc. Exactas Fis. Nat. Madr. Ser. Cienc. Nat. 8:1-403.**

Ure, D.C. and C. Maser. 1982. Mycophagy of red-backed voles in Oregon and Washington. **Can. J. Zool. 60:3307-3315.**

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THREE XYLARIACEOUS FUNGI WITH SCOLECOSPOROUS CONIDIA

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ABSTRACT

The scolecosporous anamorphs of *Lopadostoma turgidum, Creosphaeria sassafras* comb. nov., and a fungus close to "*Nummularia*" *viridis* are described and illustrated from culture. Both *L. turgidum* and "*Nummularia*" sp. produce slimy conidia in definite conidiomata. *Creosphaeria sassafras* produces slimy conidia from mycelia and from stromatic structures. The placement of these fungi in the Xylariaceae and their resemblance to certain Diatrypaceae is discussed.

Key words: anamorph, *Creosphaeria,* Diatrypaceae, *Hypoxylon*, *Lopadostoma,* Xylariaceae

One of the hallmarks of taxa of family Xylariaceae is the type of hyphomycetous anamorph that features dry amerosporous conidia produced holoblastically from sympodially proliferating conidiogenous cells (Rogers, 1979; 1985). Hyphomycetous genera associated with various taxa include *Nodulisporium* Preuss, *Geniculosporium* Chesters & Greenhalgh, *Lindquistia* Subram. & Chandrashekara, *Xylocladium* Sydow and *Acanthodochium* Samuels, Rogers, & Nagasawa. We report herein on three xylariaceous fungi that, in culture, produce more or less slimy scolecosporous conidia holoblastically from sympodially proliferating or sympodially and percurrently proliferating conidiogenous cells.

Two of them produce conidia in conidiomata. These taxa do not seem to be especially closely related to each other---indeed representing different genera---but seem even further removed from taxa with dry conidia. We believe that these fungi represent a distinct and heretofore unrecognized evolutionary line in the Xylariaceae, as will be discussed later herein.

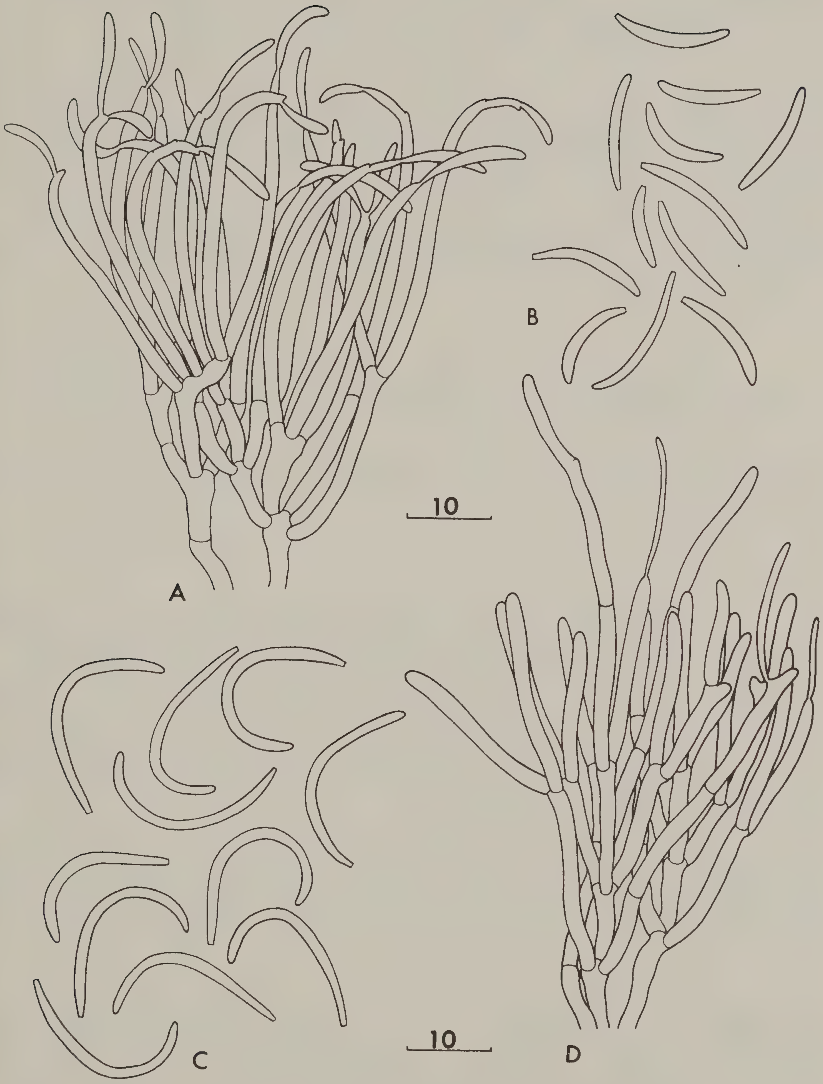
Lopadostoma turgidum

Lopadostoma turgidum (Pers.:Fr.) Traverso was discussed by the Tulasne brothers (1863) (as *Sphaeria turgida* Pers.) who recognized that the valsoid configuration of the stroma is deceptive and remarked that the ascospores resemble hypoxyloid (xylariaceous) genera. They did not detect spermogonia, i.e. conidiomata. Nitschke (1867) described the conidial state of *L. turgidum* (as *Anthostoma*) as consisting of multiloculate spermagonia with cylindrical curved hyaline spermatia produced acrogenously from densely caespitose short simple sterigmata. Elsewhere, he gave dimensions of conidia as 10 x 1.5 μm (1867). Traverso (1906) cited *Cytospora turgida* (Nitschke) Traverso as the pycnidial state of *L. turgidum*.

We received a collection of *Lopadostoma turgidum* from Françoise Candoussau. This material seemed typical of the species except that the ascospores, (7.5-)8-11.5 X 4-4.5 μm, ranged shorter than reported by some authors and more narrow than reported by most authors: 8-12 X 7-8 μm (Arx & Müller, 1954); 10-13 X 5-6 μm (Dennis, 1978); 8-12 X 7-8 μm (Ellis & Everhart, 1892); 10-13 X 5-6 μm (Munk, 1957); 8-12 X 4-7 μm (Nitschke, 1867); 8-12 X 6-8 μm (Traverso, 1906); 8-12 X 7-8 μm (Winter, 1887). Interestingly, Saccardo (1908) described *L. turgidum* var. *minus* Sacc. (as *Anthostoma*) with ascospores 8-9 x 4.5-5 μm from *Quercus* and *Castanea* in France. It is possible that the present fungus represents this taxon. We have cultured the fungus. The anamorph is illustrated in Fig.1 C, D and described, as follows.

Colonies on 2% Difco Oatmeal Agar incubated at ca 20°C under 12 hr fluorescent light not reaching the edge of Petri dish in 2 months, at first white, velvety, azonate, with entire or slightly lobed margins; becoming pale luteus, overlain with sporadic cottony mycelial masses usually associated with clear exudates and condiogenesis. Reverse uncolored. Conidiomata convoluted or multiloculate with black wall ca. 0.2 mm thick, composed of prosenchymatous elements 2.5-3 μm broad encrusted with black material. Conidiophores di- or trichotomously branched, with yellowish stipes that become paler and then hyaline upwards, smooth-walled, arranged in dense palisades. Conidiogenous cells terminal, cylindrical, 15-30 X 1.5-2 μm, smooth-walled, bearing inconspicuous conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, orange in slimy masses, smooth, strongly curved to semicircular, 22-29 X 1.2-1.5 μm, (semicircular conidia 12-20 μm measured between the ends)

Fig. 1. "*Nummularia*" sp. and *Lopadostoma turgidum*. A and B. "*Nummularia*" sp. A. Conidiophores and conidiogenous cells. B. Conidia. C and D. *Lopadostoma turgidum*. C. Conidia. D. Conidiophores and conidiogenous cells.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with flattened bases ca. 0.5 μm broad indicating former points of attachment to conidiogenous cells. Conidia not germinating in culture or in germination trials.

Culture deposited in American Type Culture Collection.

SPECIMENS EXAMINED: AUSTRIA. Niederdonau, Rotgraben bei Klosterneuburg, V.1939, Petrak F. "Mycotheca generalis," wood of *Fagus silvatica*, as *Lopadostoma turgida* (WSP 18268); FRANCE. Carcassonne, Montreal, 8.XII.1991, Candoussau, F. 231-A, on bark of *Quercus ilex* (JDR) (COLLECTION FROM WHICH CULTURE IS DESCRIBED); Carcassonne, Montreal, 8.XII.1991, Candoussau, F. 231, on bark of *Quercus ilex* (JDR) (LARGE-SPORED FUNGUS CULTURED, BUT NOT DESCRIBED IN DETAIL). MEXICO. Tamaulipas, Victoria municipality, "El Madrono," IX.1992, San Martín, F. 1487, on wood of *Quercus* (ITCV).

Another fungus was also sent by Candoussau and was cultured. It greatly resembled *L. turgidum* except that the ascospores ranged longer, (10.5-)11-16.5 X 4.5-5 μm. This fungus is a variant of *L. turgidum*, another species buried in *Anthostoma*, or a new species. In any case, cultures were similar to the above-described except that they became blackish and incipient conidiomata did not produce conidia.

Creosphaeria sassafras

Theissen (1910) erected *Creosphaeria* Theiss. based upon *Creosphaeria riograndensis* Theiss. for taxa with soft light-colored stromata and brown ascospores, remarking that the genus--"Rosellinae proximum--". Petrak (1923) believed *Anthostoma* to be closely related to *Creosphaeria*. Later, Petrak (1951) recognized that *Creosphaeria riograndensis* is conspecific with *Hypoxylon sassafras* (Schwein.:Fr.) M. A. Curtis. Miller (1961) put *C. riograndensis* into synonymy with *H. sassafras*, the nomenclaturally much older taxon.

Martin (1967) cultured *Hypoxylon sassafras*, reporting the conidia to be oval to subglobose, 1.7-3.7 X 1.7-2.7 μm. Petrini and Müller (1986), however, reported and illustrated the anamorph from culture as belonging to *Libertella* Desm., describing the conidia as crescentic, hyaline, one-celled, 13-26 X 1-2 μm. We have recently cultured the fungus from European and Asian material. Our results agree essentially with those of Petrini and Müller (1986) except that we have observed conidia on stromata as well as associated with rudimentary conidiomata in the aerial hyphae. Because this type of anamorph differs from those of most *Hypoxylon* species we herein resurrect *Creosphaeria*, based upon *Sphaeria sassafras* Schwein. It is noteworthy in this respect that Petrak (in Sydow & Petrak, 1922) erected *Creosphaeria pinea* Petrak for a fungus widely accepted as *Hypoxylon diathrauston* Rehm [≡ *Rosellinia diathrausta* (Rehm) L. Petrini]. The anamorph of this fungus is of the typical xylariaceous type (Petrini and Müller, 1986). We do not accept it as a *Creosphaeria*. According to Miller (1961), Rick erected *Creosphaeria verruculosa* Rick. We have not seen material of this fungus and, thus, have no opinion on its placement.

Creosphaeria sassafras (Schwein.: Fr.), comb. nov.

BASIONYM: *Sphaeria sassafras* Schwein., Schr. Nat. Ges. Leipzig 1:36. 1822.
≡ *Sphaeria sassafras* Schwein.: Fr., Syst. Mycol. II, p. 343. 1823.
≡ *Hypoxylon sassafras* (Schwein.: Fr.) M. A. Curtis, Geol. & Nat. Hist. Survey N. C. pt. III, p. 140. 1867.
= *Sphaeria callostroma* Schwein., Jour. Acad. Nat. Sci. Phila. 5:15. 1825.
≡ *Hypoxylon callostroma* (Schwein.) Berk., Grevillea 4:51. 1875.
= *Hypoxylon bifrons* De Not., Sphaer. Ital. Cent. I, p. 18. 1863.
? = *Sphaeria prinicola* Berk. & M. A. Curtis, Grevillea 4:142. 1876.
≡ *Rosellinia prinicola* (Berk. & M. A. Curtis) Sacc., Syll. Fung. I, p. 263. 1882.
? = *Rosellinia linderae* Peck, 49th Rep. N. Y. State Mus., p. 24. 1896.
= *Hypoxylon valsarioides* Speg., Fungi Chilenses, p. 48. 1910.
= *Creosphaeria riograndensis* Theiss., Beih. Bot. Centralb. 27:396. 1910.
? = *Anthostomella sinensis* Teng & Ou, Sinensia 7:198. 1936.

The teleomorph is as described by Miller (1961) and Petrini & Müller (1986). The anamorph is illustrated in Fig. 2 A-E and described as follows.

Colonies on 2% Difco Oatmeal Agar incubated at 20°C under 12 hr fluorescent light covering Petri dish in 4 wk, at first white, felty, azonate, with diffuse margins and pinkish diffusible pigment, becoming overlain with a blackish gray layer of floccose hyphae. Reverse uncolored. Stromata formed in old cultures, scattered, appressed cushion-shaped, 2-5 mm diam x ca. 1 mm high, black. Conidium-bearing regions on surfaces of both mycelium and stromata, or in mycelial cavities. Conidiophores dichotomously branched, with brown stipes that become paler upwards, smooth-walled, loosely arranged when arising from aerial hyphae but in dense palisades when arising from stromata and mycelial cavities. Conidiogenous cells terminal, cylindrical, 10-22 x 2-3 μm, smooth-walled, often bearing denticulate conidial secession scars, infrequently with several annellations. Conidia produced holoblastically in sympodial sequence or from percurrently proliferating conidiogenous cells. Conidia hyaline, wet to somewhat slimy, smooth, strongly curved, (13-)15-22 x 1.5-2 μm, with flattened bases ca. 0.5 μm broad indicating former points of attachment to conidiogenous cells. Conidia germinating in culture.

Culture deposited in American Type Culture Collection.

SPECIMENS EXAMINED: BRAZIL. Sao Leopoldo, 1909, leg. Theissen, in Rick, J. "Fungi Austro-Americani" no. 316, on corticated wood, as *Creosphaeria riograndensis* Theiss. (BPI;TYPE). CHILE. no. 1965. Microscope slide of Shear, C. L. Labelled as type of *Hypoxylon valsaroides* Speg. (BPI). FRANCE. Bugangue, Oloron, 2.II.1992, Candoussau, F., *Fagus* (JDR) (CULTURED). ITALY. Microscope slide of Shear, C. L. bearing a portion of stroma and ascospores. Labelled as type of *Hypoxylon bifrons* De Not. from herb FI (BPI); TAIWAN. Nan-Tou County, Huei-Sun, 22.IV.1985, Ju, Y.-M., NTU-74042201, fallen corticated twigs (JDR; NTU); Taipei City, Young-Ming-Shan, 8.I.1988, Chang, T.-M., NTU-77010801, corticated wood (JDR; NTU) (CULTURED).

UNITED STATES. Pennsylvania, Bethlehem, Collins Coll. no. 39, Syn. 1208, as *Sphaeria sassafras* LVS. (PH;TYPE); Pennsylvania, Bethlehem, Collins Coll. no. 33, Syn. 1200, as *Sphaeria sassafras* LVS. (PH;TYPE). Pennsylvania, Bethlehem, Collins Coll. no. 39, Syn. 1208, as *Sphaeria callostoma* LVS (PH;?HOLOTYPE).

The anamorph of *Creosphaeria sassafras*, producing elongated conidia from conidiogenous cells that proliferate sympodially or percurrently, resembles that of *Hypoxylon microplacum* (Berk. & M. A. Curtis) J. H. Miller (Glawe & Rogers, 1986). Conidia of the latter species tend to be dry.

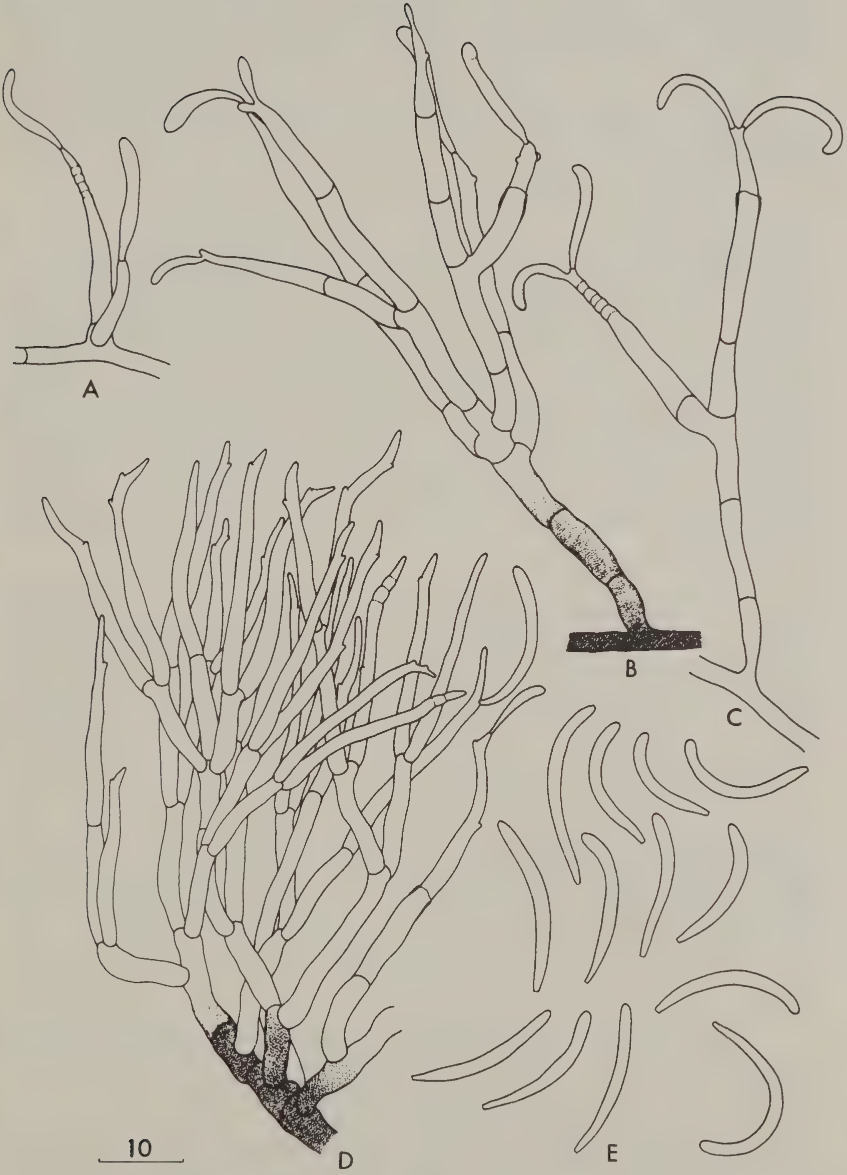
"*Nummularia*" sp.

Theissen (1908) described *Nummularia viridis* Theiss. on material collected in Brazil. Stromata were described as "--flavo-viridula, dein viridi-fuliginea margine laetiore flavidulo--." Miller (1961) put *N. viridis* into synonymy with *Hypoxylon hypophlaeum* (Berk. & Ravenel) J. H. Miller. We were unable to locate type or other material of *N. viridis* in the USA or herb. K. We examined a specimen of Rick from herb. S that is from the type locality, but is probably not type material. It is distinct from *H. hypophlaeum*. In any case, we have cultured a fungus that seems close to *N. viridis* as described by Theissen (1908). It is briefly described, as follows: Stroma applanate, 5 cm x 2 cm x <1 mm thick, smooth, cracked in the manner of *Diatrype stigma*. Exterior greenish tan, blackish beneath, but white around perithecial bases which are embedded directly in the substrate. Texture waxy. Perithecia 0.1-0.2 mm diam. Ostioles umbilicate, slightly raised, blackish. Asci short- to long-stipitate, with ascospores arranged in uniseriate or biseriate manner, ca. 90 x 5-10 μm, the spore-bearing part ca. 40 μm long, with minute plate-like ascus apical ring bluing in Melzer's iodine reagent. Ascospores brown, smooth, one-celled, ellipsoid-inequilateral, 8-10.5 x 3.5-4.5 μm, with long straight germ slit on concave part. It differs from the Rick fungus which has more discrete uncracked stromata that lack green tones, has raised black ostioles, and has ascospores that are more narrow, i.e. 3-3.5 μm.

Our fungus might or might not be conspecific with *N. viridis*. It certainly represents a new genus, based upon its elongated wet conidia borne in conidiomata and teleomorphic features, but we are not describing it as such until a broader search is made for material of *N. viridis* which might form the type of a new genus. The anamorph is illustrated in Fig. 1 A, B and described, as follows.

Colonies on 2% Difco Oatmeal Agar incubated at 20°C and 12 h of fluorescent light covering Petri dish in 5 wk, at first yellow, velvety, with diffuse margins, becoming greenish olivaceous, zonate. Reverse brownish. Conidium-bearing regions distributed on concentric zones, within or upon a stroma. Stroma superficially greenish, black beneath, slightly carbonaceous, composed of spheroid, dark, thick-walled cells 3-4.5 μm diam, overlying white prosenchymatous layer.

Fig. 2. *Creosphaeria sassafras*. A-D. Conidiophores and conidiogenous cells showing conidial production and conidiogenous cells proliferating sympodially and/or percurrently. E. Conidia.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Conidiophores di- or trichotomously branched, with hyaline to pale brown stipes, smooth-walled, arranged in dense palisades. Conidiogenous cells terminal, cylindrical, smooth, 25-40 x 1.5-2 μm, bearing slightly denticulate secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, orange in slimy masses, smooth, slightly curved, 10-17 x 1.2-1.8 μm, with flattened bases ca. 0.5 μm broad indicating former points of attachment to conidiogenous cells. Conidia not germinating.

Culture deposited in American Type Culture Collection.

SPECIMENS EXAMINED: BRAZIL. Nova Petropolis, Rick, J. 226, as *Nummularia grisea* Rick (BPI;TYPE); Sao Leopoldo, 1906, Rick, J., as *Hypoxylon grisea* Rick (BPI). Sao Leopoldo, III.1908, Rick, as *Nummularia viridis* Theiss. (S). MEXICO. Nuevo León, Santiago, El Cercado, 16.IV.1988. San Martín, F. #428, on *Quercus*, as "Nummularia" sp. (ITCV;JDR) (CULTURED). USA. Louisiana, St. Martinsville, 28.III.1890, Langlois, "Fungi Ludoviciana: no. 2278, as *Hypoxylon cinereum* Ellis & Everh. (NY,TYPE); New Jersey, Newfield, IV.1894, Ellis, J. B. "Fungi Columbiana" 429, on *Magnolia glauca*, as *Nummularia hypophloea* (Berk. & Ravenel) Cooke (WSP 4783); South Carolina, Monck's Corner, 26.X.1923, as *Hypoxylon hypophlaeum* (Berk. & Ravenel) J. H. Miller (BPI); South Carolina, 1855, Ravenel, "Fung. Carol., Fasc. 4, no. 38, as *Diatrype hypophloea* Berk. & Ravenel (BPI).

The teleomorphic stroma of this fungi resembles that of *Hypoxylon microplacum*. The conidia likewise resemble those of *H. microplacum*, but those of this latter fungus are dry and not formed in conidiomata. A search of herbarium specimens did not settle the identity of the fungus that we cultured. It did, however, reveal that *Hypoxylon grisea* Rick, based on the type, and another Brazilian specimen cited as *H. grisea* are neither conspecific nor to be equated with *H. hypophlaeum* as Miller (1961) believed. Likewise, examination of type material of *Hypoxylon cinereum* revealed that it is probably a taxon distinct from *H. hypophlaeum*. One might be tempted to remove all of these taxa to *Biscogniauxia* O. Kuntze on the basis of teleomorphic features. It is suspected, however, that cultures could reveal anamorphic differences that would influence generic assignment. We thus continue to use old and untenable generic names.

DISCUSSION

The fungi described herein appear to represent an evolutionary line in the Xylariaceae, based primarily on the anamorphs. Scolecosporous conidia are unusual among cultured Xylariaceae. Wet to slimy conidia borne in or on conidiomata represent a striking contrast to the dry-spored hyphomycetous states of most investigated xylariaceous fungi. Interestingly, the fungi described here--although possessing cardinal xylariaceous features such as brown ascospores with germ slits and amyloid ascus rings--differ developmentally among themselves. *Lopadostoma turgidum* develops in a more or less valsoid manner within bark and wood. *Creosphaeria sassafras* appears to develop in the manner of the colored *Hypoxylon* species, i.e. as an erumpent stroma that develops perithecia in the periphery following conidial production on the stroma. "*Nummularia*" sp. apparently has a bipartite stroma of the type associated with *Biscogniauxia* or *Camillea* Fr. (Laessøe et al, 1989). The relationships among these three taxa are presently unclear.

The anamorph of *Creosphaeria sassafras* has a resemblance to that of *Hypoxylon microplacum* in conidial shape, in having both sympodial and percurrent conidiogenous cell proliferation, and in that conidia of both species germinate to some extent. The teleomorphs, however, are developmentally quite different, that of *H. microplacum* being of the *Biscogniauxia* type. It is currently uncertain if *H. microplacum* should be removed to *Biscogniauxia* or placed in a new genus.

The anamorphs of the three species described here are reminiscent of the Diatrypaceae in the more or less slimy scolecosporous conidia produced on conidiogenous cells that proliferate sympodially and/or percurrently and in the production of more or less distinct conidiomata (see discussion by Glawe & Rogers, 1986). The conidia of *Lopadostoma turgidum* and "Nummularia" sp. have not been seen to germinate. Conidial germination has not been observed in most diatrypaceous fungi and, when observed, occurs in very low numbers (Ju et al, 1991). The conidial nucleus of many xylariaceous and diatrypaceous fungi occupies much of the volume of the spore (Glawe and Rogers, 1986; Roe, 1974). This is true for conidia of "Nummularia" sp., the only species examined cytologically.

We do not yet know the relationships of the Xylariaceae with the Diatrypaceae. In 1986 Glawe and Rogers wrote that the Diatrypaceae and the Xylariaceae probably arose from a common ancestor. It was stated therein that the Xylariaceae depend exclusively on air-dispersed conidia (Glawe & Rogers, 1986). Obviously, our impression of the Xylariaceae is now amended to include taxa with water-dispersed conidia that, in some cases, are borne in (or on) conidiomata. The interfaces of the Xylariaceae and Diatrypaceae remain unclear.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Arx, J. A. von & E. Müller. 1954. Die Gattungen der amerosporen Pyrenomyceten. Beitr. Kryptogamenfl. Schweiz 11:1-434.

Dennis, R. W. G. 1978. British Ascomycetes. J. Cramer. Vaduz. 385 p.

Ellis, J. B. & B. M. Everhart. 1892. North American pyrenomycetes. Newfield, New Jersey. 793 p.

Glawe, D. A. & J. D. Rogers. 1986. Conidial states of some species of

Diatrypaceae and Xylariaceae. Can. J. Bot. 64:1493-1498.

Ju, Y.-M., D. A. Glawe, and J. D. Rogers. 1991. Conidial germination in *Eutypa armeniaceae* and selected other species of Diatrypaceae: Implications for the systematics and biology of diatrypaceous fungi. Mycotaxon 41:311-320.

Laessøe, T., J. D. Rogers, and A. J. S. Whalley. 1989. *Camillea, Jongiella* and light-spored species of *Hypoxylon*. Mycol. Res. 93:121-155.

Martin, P. 1967. Studies in the Xylariaceae IV. South African and foreign species of *Hypoxylon* sect. Entoleuca. J. S. African Bot. 34:153-199.

Miller, J. H. 1961. A monograph of the world species of *Hypoxylon*. Univ. of Georgia Press, Athens. 158 p.

Munk, A. 1957. Danish pyrenomycetes. Dansk Botan. Arkiv. 17:1-491.

Nitschke, T. 1867. Pyrenomycetes Germanici. Breslau. 320 p.

Petrak, F. 1923. Mykologische Notizen. 6. Ann. Mycologici 21:182-335.

Petrak, F. 1951. Engebnisse einer Revision der Grundtypen vershiedener Gattungen der Askomyzeten und Fungi Imperfecti. Sydowia 5:328-356.

Petrini, L. E. & E. Müller. 1986. Teleomorphs and anamorphs of European species of *Hypoxylon* (Xylariaceae, Sphaeriales) and allied genera. Mycologia Helvetica 1:501-627.

Roe, G. W. 1974. Fine structural studies on the asexual state of *Xylaria* and related genera. Ph.D. dissertation (2 volumes). Univ. of Liverpool.

Rogers, J. D. 1979. The Xylariaceae: Systematic, biological, and evolutionary aspects. Mycologia 71:1-42.

Rogers, J. D. 1985. Anamorphs of *Xylaria*: Taxonomic considerations. Sydowia 38:255-262.

Saccardo, P. A. 1908. Notae Mycologicae. Annales Mycologici 6:553-569 + Tab. XXIV.

Sydow, H. & F. Petrak. 1922. Ein Beitrag zur Kenntnis der Pilzflora Nordamerikas, insbesondere der nordwestlichen Staaten. Annales Mycologici 10:178-218.

Theissen, F. 1908. Novitates riograndes. Ann. Mycologici 6:341-352.

Theissen, F. 1910. Fungi riograndenses. Botanisch. Centralblatt Beihefte 27:384-411.

Traverso, J. B. 1906. Flora Italica Cryptogama. I: Fungi. Pyrenomycetae. Società Botanica Italiana. R. S. Casciano. 325 pp.

Tulasne, L. R. & C. Tulasne. 1863. Selecta fungorum carpologia. Vol. II. Paris. (English translation: W. B. Grove, 1931. Oxford University Press, Oxford).

Winter, G. 1887. Ascomyceten: Gymnoasceen und Pyrenomyceten. IN: L. Rabenhorst, ed. Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. Abtheilung 2. 2nd ed. E. Kummer, Leipzig. 925 p.

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BISCOGNIAUXIA AND CAMILLEA IN MEXICO

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ABSTRACT

Thirteen taxa of *Biscogniauxia* and fourteen taxa of *Camillea* from Mexico are considered and included in keys. Cultural and anamorphic data are presented for some taxa. A new combination, *Biscogniauxia fuscella*, is made. The new species--*Camillea guzmanii, C. magnifica,* and *C. mexicana*--are erected.

Key words: *Biscogniauxia, Camillea, Nodulisporium,* Xylariaceae, *Xylocladium*

In 1989 San Martín González and Rogers published a preliminary account of *Xylaria* Hill ex Schrank in Mexico based primarily on collections made by the former (hereinafter called San Martín) prior to 1988. In 1988 San Martín spent several months of extensive collecting in 34 principal locations in 12 Mexican states. Most of the collection locations were in the eastern, southeastern, and southern states. A detailed list of collection locations is appended to this paper. This paper, and those to follow that will deal with other genera, include data from all of San Martín's collecting activities.

Mexico is a geographically, geologically, climatically, and floristically complicated country. This is reflected in its mycoflora. References such as Rzedowski (1978) and Koeppen (1948) are indispensable to the understanding of the physical aspects and vegetation, and the climate, respectively, of Mexico. As one might suspect, mycofloristic elements of the United States, Central America, and South America are found there. Where appropriate, comments on distribution are included in the "NOTES" for each taxon.

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MATERIALS AND METHODS

Collected materials were air-dried and brought in culturable condition to Washington State University under appropriate permits issued by APHIS authorities in Hyattsville, Maryland. Teleomorphic material was placed in ITCV and JDR, the personal herbarium of J. D. Rogers. Herbarium designations follow Holmgren, *et al.* (1990).

Cultures were made from teleomorphic stromata in the following way. The upper part of a perithecium-bearing stroma was removed with a sterile razor blade. The content of the exposed perithecium was rehydrated with sterile distilled H_2O, scooped out with a sterile needle and transferred to a Petri plate containing 2% Difco potato dextrose agar amended with 5g/L of Difco yeast extract (PDYA). Following germination of ascospores, hyphal tips were severed and transferred to 2% Difco Oatmeal agar (OA) in 9 cm diam Petri plates and incubated under laboratory conditions of approximately 12 hr per day fluorescent light at 20°C. Cultures thus were considered as originating from multiple ascospores. Dried cultures were deposited in ITCV and WSP.

Conidial structures were examined by a technique involving coverslips coated with mucilage (Callan & Rogers, 1990). Anamorphic and teleomorphic structures were initially examined and measured in water. Structures were examined by brightfield (BF) microscopy, differential interference contrast (DIC) microscopy, and scanning electron microscopy (SEM). SEM techniques were as used by Rogers (1977).

Biscogniauxia O. Kuntze

Biscogniauxia largely includes lignicolous taxa that were traditionally included in the illegitimate genus *Nummularia* Tulasne or, more recently, in *Hypoxylon* Bull. (Miller, 1961; Pouzar, 1979). Stromata are applanate, more or less cylindrical, or cupulate. Stromata are usually (probably always) bipartite. An outermost layer that at first covers and occludes the ostioles is shed prior to perithecial maturity, exposing the ostioles. In cases where stromata are formed within bark, the outermost layer adheres to overlying bark when it is ruptured by the growing stroma and thrown off. Ascospores are usually brown to nearly black, smooth-walled, often nearly equilateral, possess a germ slit, and lack a dehiscent perispore. They are one-celled or, in some species, two-celled with one of the cells hyaline. The apical ascus ring is usually amyloid (bluing in Melzer's iodine reagent) and usually is broader than high. In some species the ring is reduced to a thin flat perforated plate. Known anamorphs of *Biscogniauxia* are accommodated in *Nodulisporium* Preuss.

There are among the included taxa some species or varieties that have not formally been transferred to *Biscogniauxia*. In some cases, there is substantial doubt about the actual taxonomic disposition. This is particularly true with the complex of taxa surrounding *Biscogniauxia nummularia*, some of which were considered varieties of this species (as *Hypoxylon nummularium*) by J. H. Miller (1961).

KEY TO SPECIES OF BISCOGNIAUXIA FROM MEXICO

1. Stromata with whitish-gray to white surface at maturity 2

1. Stromata with dark brown, blackish to shiny black surface at maturity . 4

2. Perithecial ostioles umbilicate to slightly raised. Ascospores brown to dark brown with one or both ends narrowly or broadly rounded, one end often bearing a minute appendage, 13.5-16 (-16.5) (including appendage) x 7-8 μm. On *Celtis laevigata* . . . . *Biscogniauxia fuscella*

2. Perithecial ostioles papillate. Ascospores larger 3

3. Ascospores (30.5-)32-34(-37) x (12-)13-15 μm. On *Quercus* spp. . . . . *Biscogniauxia atropunctata*

3. Ascospores 18.5-20(-21) x (7-)7.5-9 μm. On *Quercus* sp. . . . . *Biscogniauxia* sp. (José Castillo 1100B)

4. Ascospores brown to dark brown with one end rounded and the other truncate or bearing a hyaline to pale brown cellular appendage 5

4. Ascospores devoid of cellular appendage or notably truncate end 6

5. Perithecial ostioles indistinct. Ascospores (19-)21-24(-25) (not including appendage) x (10-)11-14.5(-15) μm, with germ slit straight running the entire length of the dark spore body . . . *Biscogniauxia divergens* var. *macrospora*

5. Perithecial ostioles umbilicate in more or less deep pits. Ascospores (10-)11-13 (not including appendage) x 6-7.5(-8) μm with germ slit straight running 3/4 of the dark spore body . . . . *Biscogniauxia grenadensis*

6. Ascospores light brown 7

6. Ascospores brown, dark brown to almost black 8

7. Perithecia 1-1.5 mm high x 1-1.7 mm broad. Ascospores ellipsoid with rounded to narrowly-rounded ends, (13-)14-19(-21) x 5-7 μm . . . . *Hypoxylon* cf. *comedens*

7. Perithecia 0.1-0.2 mm broad. Ascospores ellipsoid-inequilateral to navicular with narrow ends, 5-6 x (2-)2.5(-3) μm .... *Hypoxylon microplacum*

    8. Stromatal surface shiny black. Perithecial ostioles prominent, conic-papillate. Ascospores dark brown to almost black, 15-17.5(-19) x 7-8(-9) μm .... *Biscogniauxia mediterranea*

    8. Stromatal surface dark brown to dull black. Ostioles not prominently conic-papillate 9

9. Ascospores ellipsoid-inequilateral to navicular with narrow to acute ends, 13-16(-17) x (4.5-)5-5.5(-6) μm, with straight germ slit much less than spore-length .... *Biscogniauxia* sp. (San Martín 725)

9. Ascospores with rounded or narrow ends, with germ slit running the full spore-length or nearly so 10

    10. Ascospores subspherical with rounded ends, dark brown to almost black, (10-)11-12(-13) x 7-8(-9) μm .... *Biscogniauxia* cf. *nummularia*

    NOTE: Ascospores of Mexican material of *B. nummularia* frequently have pinched ends.

    10. Ascospores ellipsoid-inequilateral to navicular 11

11. Ascospores with narrow to narrowly-rounded ends, dark brown to almost black, (13-)13.5-17(-19) x 8-8.5 μm. Stromata on *Quercus* spp. wood in temperate forests .... *Biscogniauxia nummularia var. exutans*

11. Ascospores smaller. Stromata on wood in subtropical forests or in tropical rain forests 12

    12. Ascospores (8.5-)9-12 x 5.5-6(-6.5) μm .... *Biscogniauxia nummularia var. merrillii*

    12. Ascospores 10-12.5(-13.5) x 6.5-7(-8) μm .... *Biscogniauxia nummularia* var. "*pseudopachyloma*"

Biscogniauxia atropunctata (Schwein.) Pouzar, Ceská Mykol. 33:216. 1979.

The teleomorph is much as described by Miller (1961). Ascus apical ring bluing in Melzer's iodine reagent, cuneate, 3-3.5 μm high x 7-8 μm broad. *Ascospores* (30.5-)32-34(-37) x (12-)13-15 μm, with straight germ slit full-length on convex side. The anamorph was described by Martin (1969) (as *Numulariola atropunctata*).

SPECIMEN EXAMINED: Nuevo León state, Iturbide municipality, Ejido La Purísima, Alt. 2000 m, no date, Marmolejo 185, on wood of *Quercus* sp. in an oak forest (ITCV;JDR).

NOTES: This pathogen of *Quercus* spp. principally in the southern USA (Miller, 1961), was found in México on its expected host genus.

Hypoxylon cf. *comedens* Ces., Atti Accad. Sci. Fis. 8:19. 1879.

Teleomorph is as described by Miller (1961) except that the thickness of the stroma is greater, i.e., 1.8-4 mm vs 1-1.5 mm, and perithecia are broader, i.e., 1-2.0 mm vs 1-1.2 mm.

SPECIMEN EXAMINED: Chiapas state, Ocosingo municipality, Ejido Boca de Chajul, VIII.87, San Martín 376, on wood in evergreen tropical rain forest (ITCV;JDR).

NOTES: This fungus is similar to *Biscogniauxia* in the absence of a basal entostroma which at maturity is partially lost (as in *Ustulina* Tul. & C. Tul.), the applanate and erumpent stroma, the ostiolar pits, and the light brown, smooth ascospores. It seems most prudent, however, to await the availability of fresh material so that further observations and cultural data can be brought to bear on the taxonomic status of this fungus. Martin (1969) described material from Mexico (as *Numulariola*). He reported cultures bearing conidiophores of the *Nodulisporium* type (as *Acrostaphylus*) and of the *Xylocladium* type (as *Basidiobotrys*). This indicates that his fungus might, in fact, be a species of *Camillea*. We have not seen Martin's material, however. Type material of *H. comedens* is from Indonesia and its smooth ascospores that possibly bear a germ slit are unlike *Camillea* (Laessøe *et al.*, 1989).

Biscogniauxia divergens (Theiss.) A. J. S. Whalley & T. Laessøe *var. macrospora* (J. H. Miller) A. J. S. Whalley & T. Laessøe, Myc. Res. 94:239. 1990.

The teleomorph is much as described by Miller (1961). Ascospore germ slit straight, running the entire colored part on convex side.

SPECIMEN EXAMINED: Chiapas state, Ocosingo municipality, Montes Azules Biosphere Reserve, 21.VIII.87, San Martín 400 & 400B, on dicot wood in evergreen tropical rain forest (ITCV;JDR).

NOTES: This material is overmature, but stromatal characters, and shape and size of ascospores fit well Miller's (1961) description of *H. divergens* var. *macrospora*.

The type material of this variety was originally collected somewhere in México in 1895 by C. L. Smith. This material was identified by Berkeley as *Hypoxylon tinctor* (unpublished data) and later recognized as a new variety of *Hypoxylon divergens* by Miller (1961).

Biscogniauxia fuscella (Rehm) San Martín & J. D. Rogers, *comb. nov.*

Basionym: *Nummularia fuscella* Rehm, Ann. Mycologici 2:176. 1904.
Hypoxylon fuscellum (Rehm) J. H. Miller, Mycologia 25:325. 1933.

Stromata applanate, erumpent, 0.7-25 cm long x 0.7-2.5 cm broad x 0.5-0.7

mm high; externally whitish-gray, internally black. Texture hard but fragile. Surface smooth to undulate due to irregularities of the substrate. *Perithecia* ovoid, 0.4-0.7 mm broad. Ostioles impressed to slightly papillate. *Asci* cylindrical, eight-spored, with uniseriate spore arrangement, very short-stipitate, 100-118 μm total length x 9.5-12 μm broad, the spore-bearing part 92-106 μm, with apical ring bluing in Melzer's iodine reagent, slightly cuneate, 1.5-2 μm high x 4-4.5 μm broad. *Ascospores* brown to dark brown, ellipsoid-inequilateral to navicular, with narrowly rounded ends, or some with one end narrowly rounded and the other truncate, 13.5-16(-16.5) x 7-8 μm, with straight spore-length germ slit whose margins protrude in the manner of clam shell sutures, often with a cellular (?), hyaline appendage at one end ca. 1.5 μm long.

Colonies covering Petri plate in 3 wk, sectored, at first white, velvety, somewhat zonate, then with white, woolly growth overlaying the surface, with well-defined margins. Odor strongly yeasty. Reverse at first yellow, then green. Conidium-bearing regions over the entire surface of the colony. *Conidiophores* erect, branched, with well-defined main axis, 3-4.5 μm broad, brownish toward bases, warted. *Conidiogenous cells* terminal and lateral, di- or triverticillately branched, cylindrical, 9-15 x 3-4 μm, hyaline, bearing poroid conidial secession scars, with apices somewhat swollen due to conidial production. *Conidia* cream in mass, individually hyaline, subglobose to ellipsoid, (4.5-)5-6 x 3-4 μm, with flattened bases indicating former points of attachment to conidiogenous cell. Conidia germinating in water.

SPECIMEN EXAMINED: Tamaulipas state, Victoria municipality, Km 2 Victoria City-Matamoros City road, 5.IX.88, San Martín 1011 (CULTURED), on wood of *Celtis laevigata* Willd. ("palo blanco") in semidesertic scrub with *Pithecellobium flexicaule* (Benth.) Coult. (ITCV;JDR).

ADDITIONAL SPECIMENS EXAMINED: *Nummularia fuscella*, USA, Texas, Long 481, Cat. # 11202, (BPI;HOLOTYPE); *Hypoxylon atropurpureum* Fr. = *Hypoxylon cinereo-lilacinum* J. H. Miller, USA, Iowa, Decorah, Sept. 1882, Cat. # 1180 (BPI;ISOTYPE).

NOTES: The Mexican fungus is similar to the type of *Nummularia fuscella* Rehm. The applanate stroma, the cuneate apical ring, the color of the ascospores, and the conidial state assignable to *Nodulisporium* Preuss clearly link *N. fuscella* to species of *Biscogniauxia*. Miller (1961) had placed *N. fuscella* in his subsection Papillata of section Papillata *Hypoxylon* due to the more or less papillate ostioles. The color of the ectostroma, the shape of the ostioles, and the size of the ascospores of the

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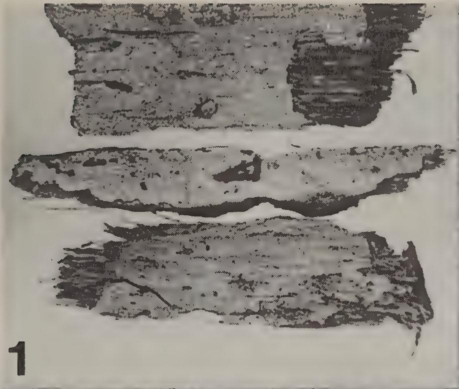
Figs. 1-8. *Biscogniauxia* sp. (José Castillo 1100B), *Camillea magnifica*, and *Camillea mexicana*. 1,2. *Biscogniauxia* sp. (J. Castillo 1100B). 1. Stromata, x 3.8. 2. Stromatal surface, x 16. 3-5. *C. magnifica*. 3. Stroma, x 6. 4. Stromatal surface, x 16. 5. Stroma (arrow) accompanied by other stromata of a *Biscogniauxia*, x 1. 6-8. *C. mexicana*. 6. Portion of stroma, x 1. 7. Stromatal surface, x 16. 8. Stromatal surface, x 24.



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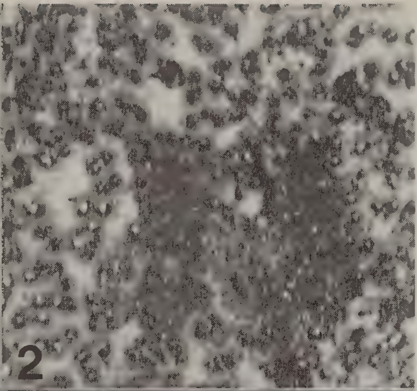

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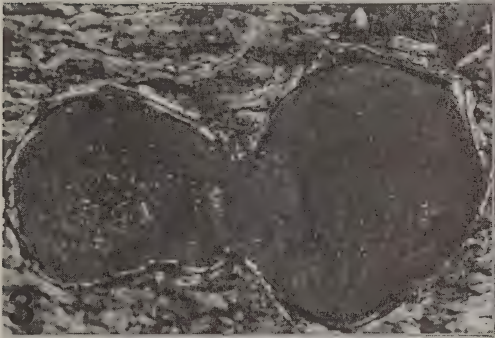

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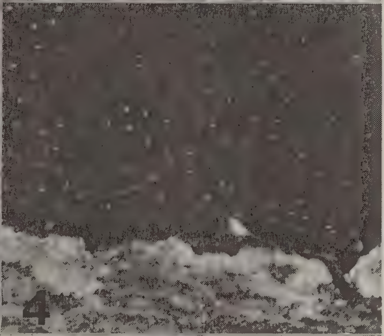

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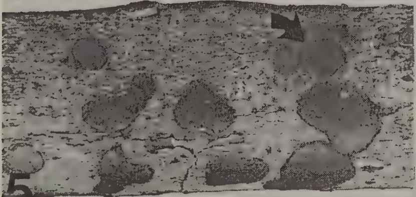

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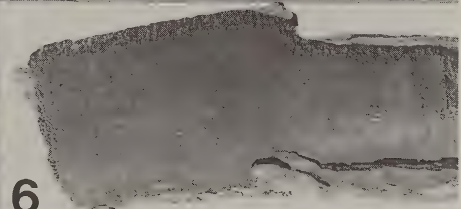

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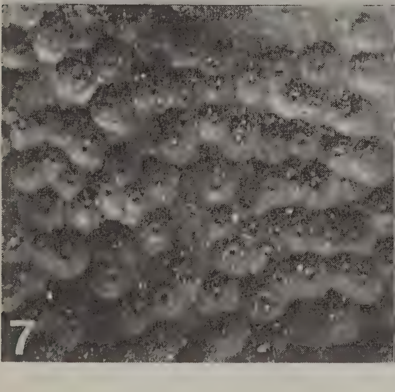

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Mexican collection are shared by *Biscogniauxia cinereo-lilacina* (J. H. Miller) Pouzar (≡ *H. cinereo-lilacinum* J. H. Miller), but the latter lacks the strong amyloid reaction of the ascal apical ring, lacks appendaged ascospores, and apparently is restricted to *Tilia* spp. in cooler localities (Miller, 1961).

Biscogniauxia grenadensis (J. H. Miller) A. J. S. Whalley & Laessøe, Myc. Res. 94:239. 1990.

Teleomorph is much as described by Miller (1961). *Ascospores* with straight, short germ slit in dark body of spore.

SPECIMENS EXAMINED: Chiapas state, La Trinitaria municipality, Montebello Lagoons, 25.V.88, San Martín 840 & 848, on dicot wood in an oak forest mixed with tropical species (ITCV;JDR); San Cristobal de las Casas municipality, El Huitepec Hill, 4.VI.88, San Martín 727, on dicot wood in oak forest (ITCV;JDR).

NOTES: Collection San Martín 727 is young, but some mature ascospores were found and these were typical of *B. grenadensis.*

Biscogniauxia mediterranea (De Not.) Kuntze, Rev. Gen. Plant. 2, p. 398. 1891.

The teleomorph is as described by Miller (1961). The anamorph was described by Martin (1969) (as *Numulariola mediterranea*), and Jong & Rogers (1972).

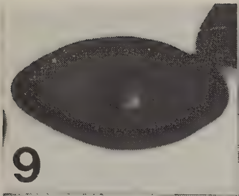
SPECIMEN EXAMINED: Tamaulipas state, Gómez Farías town, 14.IX.88, San Martín 1130, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

ADDITIONAL SPECIMEN EXAMINED: *Biscogniauxia mediterranea*, Portugal, 1969, N-275 (JDR).

NOTES: Mexican material is typical of the species. It was collected in a tropical rain forest.

Figs. 9-20. *Biscogniauxia* sp. (José Castillo 1100B), *Biscogniauxia* sp. (San Martín 725), *Camillea fossulata*. 9-11. *Biscogniauxia* sp. (J. Castillo 1100B). 9. Ascospore, x 1500. 10. Ascospore with germ slit, x 1300. 11. Ascus apical ring, x 1400. Figs. 12-14. *Biscogniauxia* sp. (SM 725). 12. Ascus apical ring, x 2300. 13. Ascospore, x 2400. 14. Ascospore with short, straight germ slit on concave side, x 2300. 15-20. *C. fossulata*. 15. Ascospore, x 2000. 16. Portions of two asci with ascospores, x 1900. 17. Ascus apical ring, x 2250. 18. Ascospore with ornamentation, x 20000. 19. Ascospore with ornamentation, x 2500. 20. Ascospore showing ornamentation, x 11000.

Figs. 9-14 by BF. Figs. 15-17 by DIC. Figs. 18-20 by SEM. Figs. 9, 10, 13-16 from water mounts. Figs. 11, 12, 17 from mounts in Melzer's reagent.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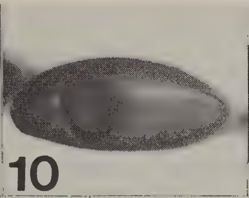
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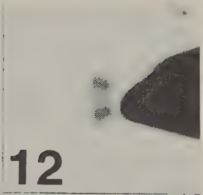
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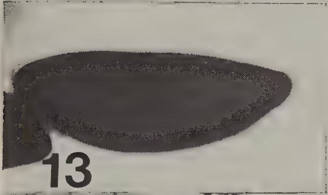
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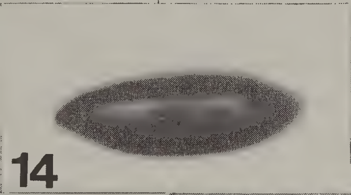
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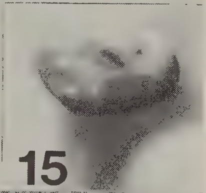
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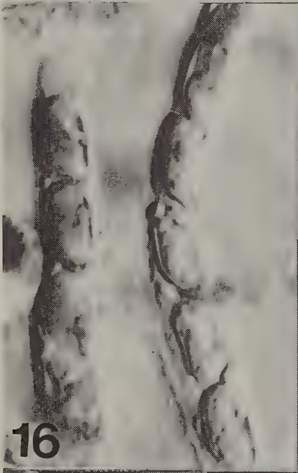
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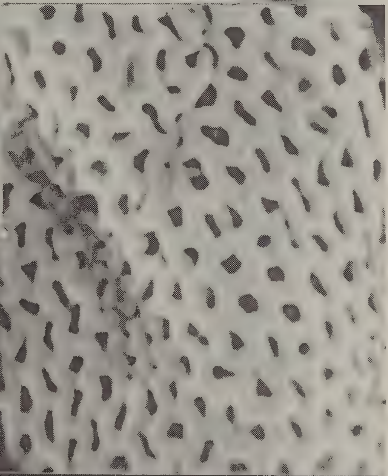
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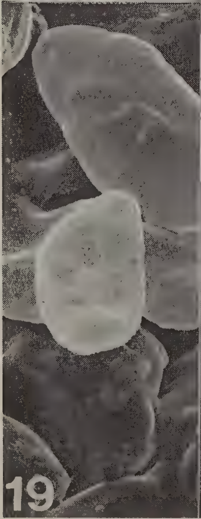
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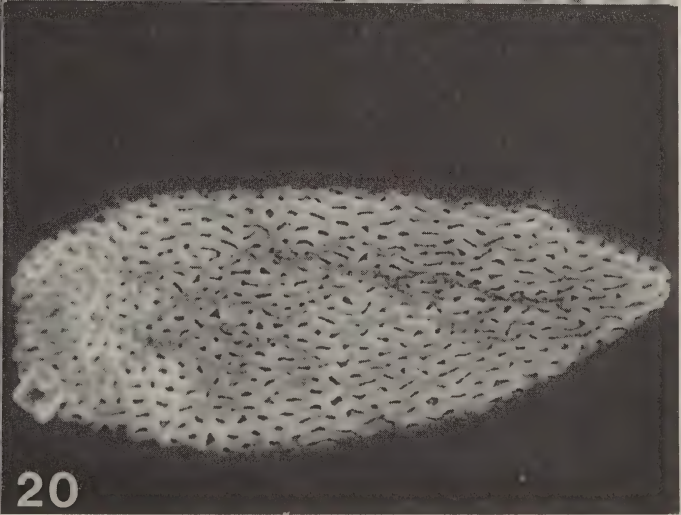
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Hypoxylon microplacum (Berk. & M. A. Curtis) J. H. Miller, Monogr. of the world species of *Hypoxylon*, p. 129. 1961.

The teleomorph is as described by Miller (1961). The anamorph is as described by Jong & Rogers (1972).

SPECIMENS EXAMINED: Tamaulipas state, Casas municipality, El Lajeadero Ranch, 8.XI.86, Jesús García 5824, on wood in submontane scrub (ITCV;JDR); Gómez Farías town, II.21.88, Chacón-Jiménez 240B, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

NOTES: This species was reported by Pérez-Silva (1983) from the state of Oaxaca, México. Martin (1969) considered it to be a *Numulariola*, but did not observe the scolecosporous conidia reported by Jong & Rogers (1972) and Glawe & Rogers (1986). We are tempted to move it to *Biscogniauxia*, but suspect that it will ultimately be placed in another genus.

Biscogniauxia nummularia (Bull.:Fr.) Kuntze *var. exutans* (Cooke) Van der Gucht, Mycotaxon 45:266. 1992.

Hypoxylon nummularium Bull.:Fr. var. *exutans* (Cooke) J. H. Miller, Monogr. of the world species of *Hypoxylon*, p. 124. 1961.

Teleomorph is much as described by Miller (1961) and Ju (1990). *Asci* cylindrical, eight-spored, short-stipitate, 119-150 μm total length x 10-11(-11.5) μm broad, the spore-bearing part 100-120 μm, with apical ring bluing in Melzer's iodine reagent, cuneate, 3(-3.5) μm high x 4 μm broad. *Ascospores* dark brown to almost black, ellipsoid-inequilateral to navicular with narrow to narrowly rounded ends, (13-)13.5-17(-19) x 8-8.5 μm, with germ slit straight spore-length on convex side.

The anamorph was described by Martin (1969) (as *Numulariola exutans*).

SPECIMENS EXAMINED: Nuevo León state, Iturbide municipality, Ejido La Purísima, Alt. 2000 m, no date, Marmolejo 199, on wood of *Quercus affinis* Mart. & Gal. in an oak forest (ITCV;JDR). Tamaulipas state, Hidalgo municipality, Ejido Conrado Castillo, VII.87, San Martín 453, on *Quercus* sp. wood in oak-pine forest (ITCV;JDR).

NOTES: This is what Miller (1961) called *Hypoxylon nummularium* var. *exutans*. We reluctantly accept it as a variety of *Biscogniauxia nummularia* because we are uncertain if it is to be considered as a variety or as *B. exutans* as Martin (1969) believed (as *Numulariola*). We require cultural and other data to reach a firm decision.

Mexican material differs from Taiwan material (Ju, 1990) in having smaller apical rings, i.e., 3(-3.5) μm high x 4 μm broad vs 5-6 μm high x 5 μm broad. The taxonomic significance of apical ring dimensions in *Biscogniauxia* is unknown.

Biscogniauxia nummularia (Bull.:Fr.) Kuntze var. *merrillii* (Bres.) Van der Gucht, Mycotaxon 45:276. 1992.

Hypoxylon nummularium Bull.:Fr. *var. merrillii* (Bres.) J. H. Miller, Monogr. of the world species of *Hypoxylon*, p. 126. 1961.

The teleomorph is as described by Miller (1961). Colony morphology and anamorphic structures were described by Ju (1990) and Martin (1969) (as *Numulariola merrillii*).

SPECIMENS EXAMINED: Campeche state, Escárcega municipality, Ing. Eduardo Sangri Serrano Forestry Experimental Station, 9.XI.88, San Martín 1180, on wood in median subevergreen tropical rain forest (ITCV;JDR). Quintana Roo state, Othón P. Blanco municipality, Tamalcab Island, 11.XI.88, San Martín 1191, on wood in low subdeciduous tropical rain forest (ITCV;JDR); Ejido La Unión, 8.XII.86, San Martín 66, on wood in median subdeciduous tropical rain forest (ITCV;JDR). Tamaulipas state, Ocampo municipality, El Tigre Hill, 8.VIII.88, San Martín 990, on wood in median subdeciduous tropical rain forest (ITCV;JDR); 10.VIII.88, Chacón 480, on wood in median subdeciduous tropical rain forest (ITCV;JDR); Gómez Farías town 16.VII.87, San Martín 225; 14.X.88, San Martín 1122, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

NOTES: This taxon poses the same problems as the previous one. We are undecided as to whether it should be considered as a variety of *Biscogniauxia nummularia* or as a separate species (see NOTES on the previous taxon). According to Ju (1990), this taxon and the following one cannot be distinguished by anamorphic characters, the only apparent difference being the slightly smaller ascospores of var. *merrillii*. There is a lack of knowledge about host preferences of both taxa.

Biscogniauxia cf. *nummularia* (Bull.:Fr.) Kuntze var. *nummularia*, Rev. Gen. Plant 2:398. 1891.

The teleomorph is as described by Miller (1961) and Petrini & Müller (1986) except that Mexican material has some spores with pinched ends.

SPECIMEN EXAMINED: Chiapas state, La Trinitaria municipality, Montebello Lagoons, 24.V.88, San Martín 802, on wood in oak-pine forest (ITCV;JDR).

NOTES: *Biscogniauxia nummularia* is primarily a European species. Despite the presence of some spores with pinched ends, Mexican material is very similar to it. On the other hand, the ascospores of this material have almost the same shape of those of *H. maculum* (Schwein.) J. H. Miller, but are smaller (see Miller, 1961 for description of *H. maculum*). Welden & Guzmán (1978) previously reported this species, as *Hypoxylon nummularium*, from the state of Veracruz.

Biscogniauxia nummularia (Bull.:Fr.) Kuntze var. "*pseudopachyloma*"
Hypoxylon nummularium Bull.:Fr. *var. pseudopachyloma* (Speg.) J. H. Miller, Monogr. of the world species of *Hypoxylon* p. 125. 1961.

The teleomorph is as described by Miller (1961). The anamorph was described by Ju (1990).

SPECIMENS EXAMINED: Chiapas state, Ocosingo municipality, Montes Azules Biosphere Reserve, 27.V.88, San Martín 780, on wood in evergreen tropical rain forest (ITCV;JDR). Nuevo León state, Santiago municipality, El Cercado, 23.X.88, San Martín 1142, on wood in submontane scrub with *Quercus* spp. (ITCV;JDR). Tamaulipas state, Gómez Farías town, 20.VII.88, San Martín 976, on wood of *Citrus sinensis* (L.) Osbeck. in an abandoned orchard.

NOTES: Material listed above seems to represent what Miller (1961) considered to be variety *pseudopachyloma* of *B. nummularia* (as *Hypoxylon*). We are presently unable to decide whether *pseudopachyloma* should be considered a variety of *B. nummularium* or a separate species as did Martin (1969) (as *Numulariola pseudopachyloma*). (See also remarks on other putative varieties of *B. nummularia* herein.)

Biscogniauxia sp. (José Castillo 1100B). Figs. 1-2, 9-11.

Stromata applanate, erumpent, covering extensive areas of the host, more than 50 cm long x 0.4-0.6 mm thick; externally at first bluish-gray then blackish-white, internally black. Texture hard. Surface uneven due to perithecial ostioles and irregularities of the substrate. *Perithecia* ovoid to more or less pyriform, 0.2-0.4 μm high x 0.1-0.3 mm broad. Ostioles prominently papillate surrounded by a blackish area. *Asci* cylindrical, eight-spored, with uniseriate spore-arrangement, very short-stipitate, 140-156 μm total length x 10-12 μm broad, the spore-bearing part 132-143 μm, with apical ring bluing in Melzer's iodine reagent, rectangular, 1.5-3 μm high x 3-4.5 μm broad. With hyaline paraphyses 8-9 μm broad at bases. *Ascospores* dark brown, ellipsoid-inequilateral to navicular with narrow to rounded ends, 18.5-20(-21) x (7-)7.5-9 μm, with straight germ slit spore-length on convex side.

SPECIMENS EXAMINED: Tamaulipas state, Casas municipality, El Lajeadero Ranch, 8.X.86, José Castillo 1100B, on wood of living *Quercus* sp. in an oak forest (ITCV;JDR); Km 45 Victoria City-Soto La Marina road, San Martín 1090, on wood of *Quercus* sp. in an oak forest (ITCV;JDR).

NOTES: In its host preference and the whitish color of the surface in mature specimens this fungus resembles *Biscogniauxia atropunctata*, but differs in the presence of blackish areas surrounding perithecial ostioles, and smaller asci, apical ring and ascospores (see descriptions of *H. atropunctatum* in Miller, 1961, and *Biscogniauxia atropunctata* herein). It might be a variant of *B. atropunctata* or even a new species. We prefer to postpone this decision until cultures are established and examined.

Biscogniauxia sp. (San Martín 725). Figs. 12-14.

Stromata applanate, erumpent, 0.9-2.5 cm long x 0.7-1 cm broad; externally and internally black. Surface smooth with papillae. Texture carbonous. *Perithecia* more or less tubular, 0.8-0.9 mm high x 0.4-0.5 mm broad. Ostioles moderately to prominently papillate-conical. *Asci* cylindrical, eight-spored, with partly biseriate spore-arrangement, short-stipitate, 117-135 µm total length x 6-7.5 µm broad, the spore-bearing part 95-106 µm, with apical ring bluing faintly in Melzer's iodine reagent, short cylindrical to slightly cuneate, 1.5-2 µm high x 2.5-3 µm broad. *Ascospores* brown, ellipsoid-inequilateral to navicular, with narrow to acute ends, 13-16(-17) x (4.5-)5-5.5(-6) µm, with germ slit straight, much less than spore-length on the flattened side.

SPECIMEN EXAMINED: Chiapas state, San Cristobal de las Casas municipality, El Huitepec Hill, 4.VI.88, San Martín 725, on wood in oak forest (ITCV;JDR).

NOTES: Stromatal characters of this species are reminiscent of *Hypoxylon nummularium* var. *theissenii* (Sydow) J. H. Miller, but the ascospores have narrow to acute ends and the germ slit is shorter than that of the ascospores as depicted by Miller (1961).

Camillea Fr.

Camillea Fr. includes taxa with stromata that are applanate, cylindrical, or broadly conic-truncate. They are usually dark brown or black and highly carbonaceous. The stroma is bipartite, the outermost layer shed to expose the ostiolar openings. Ostioles take various forms and configurations and are highly diagnostic for many species. A single ostiolar canal services one or several perithecia, depending upon the species. Asci feature apical rings that blue in Melzer's iodine reagent, are approximately as broad as high, and are rhomboid or diamond-shaped. Ascospores are almost hyaline, pale yellow, or light brown and lack a germ slit. By light microscopy the ascospores appear smooth to granular or slightly ornamented. By scanning electron microscopy they are seen to be ornamented with warts, spines, pits, reticulations, or ribs combined with an intricate substructure. Anamorphs where known are accommodated in *Xylocladium* Sydow (= *Basidiobotrys* Höhnel). Many of the species now recognized as *Camillea* were, until recently, included in *Nummularia* or *Hypoxylon*. A recent contribution toward a monograph of *Camillea* reviews most current information on the genus (Laessøe *et al.*, 1989).

KEY TO SPECIES OF CAMILLEA FROM MEXICO

1. Ascospores light brown to brown, verrucose or echinulate 2

1. Ascospores subhyaline to light brown, punctate to reticulate or more complexly ornamented (ornamentation seen clearly only by SEM) 3

    2. Stromata short-cylindrical or pulvinate, protruding 3 mm or more above the host surface level. Ostioles papillate-conical to hemispheric. Ascospores (9-)10-11(-12) x 4-5 µm . . . . *C.* cf. *verruculospora*

    2. Stromata nearly applanate, or short cylindrical, not protruding more than 3 mm above the host surface level (in our material). Ostioles obscure to slightly papillate. Ascospores 12-16 x 5-6

μm . . . . *C. obularia*

3. Stromata pulvinate or short-cylindrical, at least 3 mm above the host surface level 4

3. Stromata applanate, not reaching 3 mm above the host surface level . . 6

    4. Ostioles in radiating depressions. Ascospores (12-)13-15 x 3.5-4(-5) μm . . . . *C. stellata*

    4. Ostioles not in radiating depressions 5

5. Stromata with mucronate-labiate apex. Ascospores cylindrical, 8-9 x 4-5 μm . . . . *C. mucronata*

5. Stromata with the upper part discoid-convex. Ascospores navicular to somewhat crescentic, (13.5-)14-16 x 4(-4.5) μm . . . . *C. labellum*

    6. Ascospores ellipsoid with one end beveled 7

    6. Ascospores ellipsoid-inequilateral, navicular, or crescentic, with both ends more or less similar 10

7. Ostioles in minute pits. Ascospores 8-10(-11.5) x (3.5-)4-4.5(-5) μm. Stromata chiefly on *Quercus* wood . . . . *C. punctulata*

7. Ostioles not in minute pits 8

    8. Ostioles papillate, not located in depressions. Ascospores (7-)7.5-10.5(-11) x 4-4.5 μm . . . . *C. hainesii*

    8. Ostioles located in depressions 9

9. Depressions tending to remain separate, generally 1 ostiole per depression. Ascospores (7.5-)8-9(-10) x 4-4.5(-5) μm . . . . *C. fossulata*

9. Depressions tending to coalesce, generally more than one ostiole per depression. Ascospores 9-11 x 4-5 μm . . . . *C. mexicana sp. nov.*

    10. Ascospores 21 μm or longer 11

    10. Ascospores less than 21 μm long 13

11. Ostioles prominently papillate, on the upper part of hemispheric projections surrounded by depressions. Ascospores (20-)22-29(-30) x 8-9 μm . . . . *C.* cf. *gigaspora*

11. Ostioles not on the top of hemispheric projections; stromatal surface between ostioles plane 12

    12. Ascospores (19-)21-24 x (4.5-)5-6 μm. Ascus apical ring

somewhat rectangular, discrete, flaring upward, 3-4 μm high . . . . *C. guzmanii sp. nov.*

12. Ascospores (22-)23-33 x (7-)8-9 μm. Ascus apical ring cup-shaped, massive, (12-)12.5-14(-14.5) μm high x 5-6 μm broad . . . . *C. magnifica sp. nov.*

13. Ostioles obscure to conspicuously papillate; wood beneath stromata usually stained orange. Ascospores 13-20(-21) x 6-9 μm . . . . *C. tinctor*

13. Ostioles obscure to punctate; wood beneath stromata never orange-stained. Ascospores (13-)15-19 x (6-)7-7.5(-8) μm . . . . *C. cyclisca*

Camillea cyclisca (Mont.) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:128. 1989.

Teleomorphic features and a *Xylocladium* anamorph were discussed in Laessøe *et al.* (1989).

SPECIMENS EXAMINED: Chiapas state, Ocosingo municipality, Ejido Boca de Chajul, VII.87, San Martín 371, on wood in evergreen tropical rain forest (ITCV;JDR). Tamaulipas state, Gómez Farías town, VII.87, San Martín 380, on wood in median subdeciduous tropical rain forest (ITCV;JDR); Ocampo municipality, 16.V.88, San Martín 672, on wood in low subdeciduous tropical rain forest (ITCV;JDR).

NOTES: This taxon seems to be related to *C. tinctor*. The latter stains wood beneath the stromata orange; *C. cyclisca* does not. The differences between these taxa are subtle.

Camillea fossulata (Mont.) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:131. 1989. Figs. 15-20.

Teleomorph is as described in Laessøe *et al.* (1989) except that ascospores are hyaline instead of dilute yellow, and ascus apical rings are diamond-shaped instead of urn-shaped. Ascospore surface under SEM is punctate-reticulate.

SPECIMENS EXAMINED: Chiapas state, Ocosingo municipality, "Montes Azules" Biosphere Reserve, 28.V.88, San Martín 811, on wood in evergreen tropical rain forest (ITCV;JDR); Ejido Boca de Chajul, 29.V.88, San Martín 861, on wood in evergreen tropical rain forest (ITCV;JDR).

NOTES: It appears that examination of more material with asci and ascospores in good condition, as well as cultural data, are needed in order to achieve a better concept of this taxon. It seems to be collected fairly regularly in the tropics, but seldom with ascospores and asci in good condition.

Camillea cf. *gigaspora* (Massee) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:132. 1989.

Teleomorphic features are described in Miller (1961) under *Hypoxylon hemisphaericum* J. H. Miller; ascospore ornamentation is as described by Rogers (1977) for *H. hemisphaericum.*

SPECIMEN EXAMINED: Chiapas state, Ocosingo municipality, Ejido Pico de Oro, 31.V.88, San Martín 884, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

NOTES: Few ascospores were found in this material. Nevertheless, their shape and size, and the characteristic disposition of the perithecial ostioles permitted a certain degree of confidence about the specific identity.

Camillea guzmanii sp. nov. Figs. 28-31

Stroma fragmentarium, applanatum, erumpens, 4-5 mm longum x 3-3.5 mm latum x 0.7-1 mm crassum, marginibus sterilibus distinctis; extus atrum; intus nigellum. Textura dura. Perithecia ampulliformia, 0.4-0.6 mm alta x 0.3-0.4 mm lata. Ostiola indistincta vel parum papillata. Asci octospori, cylindrici, stipitati, 188-203 μm longitudine x 7-8 μm crassi, partibus sporiferis 135-145 μm, annulo apicali in liquore iodata Melzeri immerso cyanescente, rotundato ad basim et sursum aliquantum infundibuliformi, 3-4 μm alto x 3-4 μm lato. Paraphyses persistentes, septatae, 5.5-9.5 μm latae. Ascosporae luteolae, unicellulares, ellipsoideo-inequilaterales vel plus minusve lunatae, extremis angustis vel acutis, sub lente laeves, per SEM observatae punctato-reticulatae, (19-)21-24 x (4.5-)5-6 μm. Rima germinationis nulla.

Stroma fragmentary, applanate, erumpent, 4-5 mm long x 3-3.5 mm broad x 0.7-1 mm high, with distinct sterile margins; exterior black; interior dark. Texture hard. Perithecia flask-shaped, 0.4-0.6 mm high x 0.3-0.4 mm broad. Ostioles obscure to slightly papillate. Asci eight-spored, cylindrical, stipitate, 188-203 μm total length x 7-8 μm broad, the spore-bearing part 135-145 μm, with apical ring bluing in Melzer's iodine reagent, rounded at the base and flared upward, 3-4 μm high x 3-4 μm broad. Paraphyses persistent, septate, 5.5-9.5 μm broad. Ascospores pale yellow, unicellular, ellipsoid-inequilateral to somewhat crescentic, with narrow to acute ends, smooth by light microscopy, punctate-reticulate by SEM,

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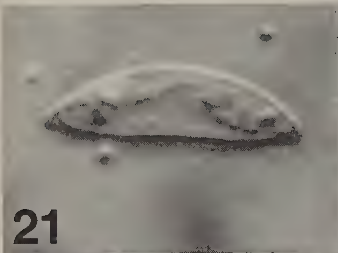
Figs. 21-31. *Camillea labellum* and *C. guzmanii.* 21-27. *C. labellum.* 21. Ascospore, x 2425. 22. Ascospore in upper part of ascus, x 5000. 23. Ascus apical ring, x 2900. 24. Ascospore showing ornamentation, x 5000. 25. Detail of ascospore ornamentation, x 15000. 26. Anamorph. Ampulla with conidiogenous cells and conidial primordium (arrow), x 1650. 27. Conidiogenous cells bearing conidia (arrow), x 1650. 28-31. *C. guzmanii.* 28. Ascospore, x 1400. 29. Ascus apical ring, x 2300. 30. Ascospore showing ornamentation, x 4000. 31. Detail of ascospore ornamentation, x 15000.

Figs. 21, 22, 26-28 by DIC. Figs. 23 and 29 by BF. Figs. 24, 25, 30, 31 by SEM. Figs. 21, 22, 26-28 from water mounts. Figs. 23 and 29 from mounts in Melzer's reagent.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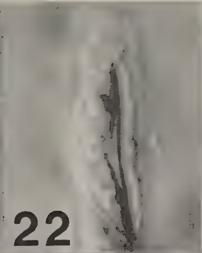
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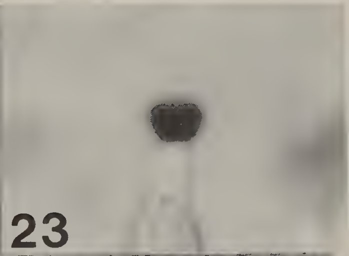
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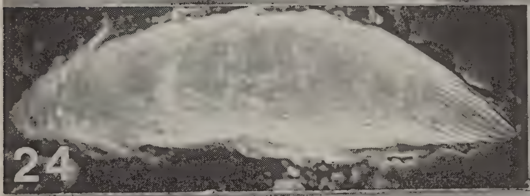
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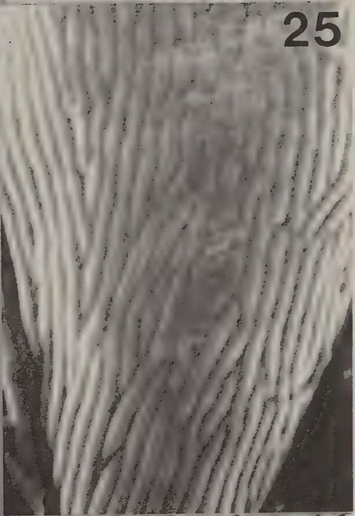
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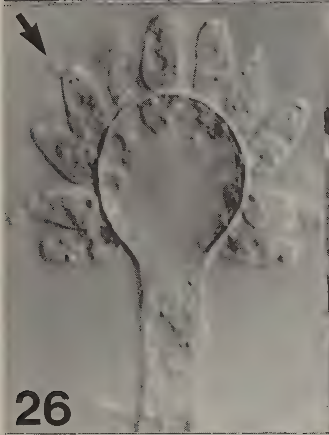
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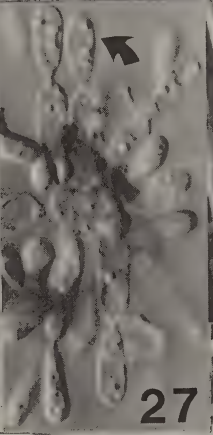
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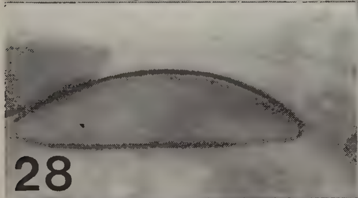
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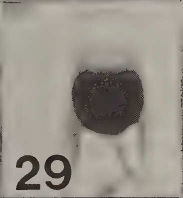
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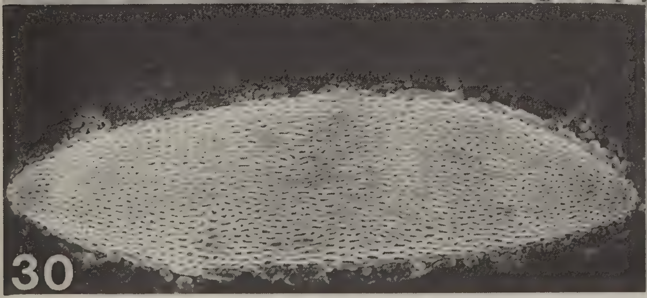
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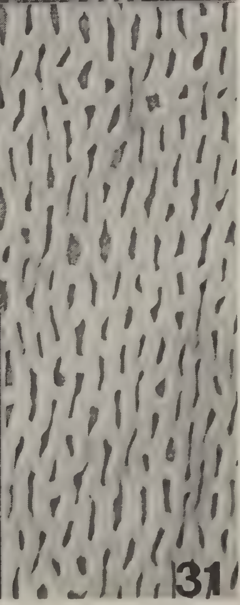
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(19-)21-24 x (4.5-)5-6 µm. Lacking a germination slit.

SPECIMEN EXAMINED: Veracruz state, Catemaco municipality, Catemaco-Montepío road, 4.XI.88, San Martín 1399, on wood in evergreen tropical rain forest (ITCV,HOLOTYPE).

NOTES: *Camillea guzmanii* differs from *Camillea magnifica* described herein, in having obscure to slightly papillate ostioles instead of punctate ones, in having a much smaller ascus apical ring, i.e. 3-4 µm high x 3-4 µm broad vs (12-)12.5-14(-14.5) µm high x 5-6 µm broad, and in having shorter ascospores, i.e. (19-)21-24 x (4.5-)5-6 µm vs (22-)23-33 x (7-)8-9 µm. Both species have a similar poroid-reticulate ascospore ornamentation seen by SEM, but pores in *C. guzmanii* are more elongated. The Mexican fungus shares with *Camillea hyalospora* (Pat.) J. D. Rogers, Laessøe, & Lodge its slightly papillate ostioles, but the latter has larger ascospores, i.e. 26-31 x (5-)7.5-9 µm. Ascospore ornamentation of *C. hyalospora* as seen by SEM is poroid-reticulate but has more elongated pores than those of *C. guzmanii* [see Rogers, 1975b for ascospore ornamentation of *N. hyalospora* (as *Hypoxylon glycyrrhiza* Berk. & M. A. Curtis), and Rogers *et al.*, 1991 for description of *C. hyalospora*].

Camillea guzmanii is named after the eminent Mexican mycologist, our friend Gastón Guzmán.

Camillea hainesii (J. D. Rogers & Dumont) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:134. 1989.

Teleomorph was described by Rogers & Dumont (1979) as *Hypoxylon hainesii* based on fragmented material. *Stromata* applanate, orbicular, erumpent, with sterile margins, 0.9-2.5 cm long x 5-7 mm broad x 0.3-0.8 mm high. *Ascospores* rectangular to ellipsoid, with one end somewhat acute, the other rounded, (7-)7.5-10.5(-11) x 4-4.5 µm.

SPECIMENS EXAMINED: Chiapas state, Ocosingo municipality, "Montes Azules" Biosphere Reserve, 30.V.88, San Martín 823 and 872, on wood in evergreen tropical rain forest (ITCV;JDR). Oaxaca state, Temazcal town, 8.X.88, San Martín 1093, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

NOTES: Compared with type material of *C. hainesii* (see Rogers & Dumont, 1979), the Mexican collections differ in having ascospores more variable in shape and in being slightly larger both in length and width.

Camillea labellum Mont., Ann. Sci. nat. Bot. 4:113. 1855; *Sensu* Dennis, Kew Bull. 2:319. 1957. Figs. 21-27.

Teleomorph described in Dennis (1957) and Laessøe *et al.* (1989). Ascospores are smooth under LM, but are seen by SEM to be composed of closely packed rod-shaped elements.

Colonies covering 9 cm diam Petri dish in 11 days, with mycelium at first white with yellowish tones, then turning pale-yellow, floccose, becoming felty in old colonies; margin indistinct, with peripheral hyphae woolly to somewhat appressed. Odor strongly yeasty which by continuous transferring gradually disappears. Reverse at first yellowish then greenish, finally dark-green. Conidia produced in 15 days. Hyphae septate, hyaline, of two types: one torulose ca. 4 μm broad, the other even, 6 μm broad. *Conidiophores* upright, with determinate growth, arising singly and laterally from hyphae, each composed of a mononematous, smooth stipe more than 450 μm long, terminated by a swollen ampulla. *Ampullae* subglobose to clavate, 10-12 x 16-18 μm, bearing conidiogenous cells, with poroid scars at the point of conidiogenous cell attachment. *Conidiogenous cells* hyaline, continuous, oblong-elliptical, inflated at the apex, numerous, often closely compacted on the surface of the ampullae, 5-9 μm high x 2-4 μm broad, with conspicuous secession scars. *Conidia* grayish in mass, hyaline individually, borne on the upper part of conidiogenous cells or directly from apparently unspecialized hyphae, ellipsoid to somewhat allantoid with one end rounded, the other truncate to somewhat attenuated, bearing basal scar indicating former point of attachment to conidiogenous locus, 6-11(-13) x (2-)2.5-3 μm, with internal oil droplets.

SPECIMENS EXAMINED: Campeche state, Escárcega municipality, "Ing. Eduardo Sangri Serrano" Forestry Experimental Station, 9.XI.88, San Martín 1181C, on wood in median subevergreen tropical rain forest (ITCV;JDR). Chiapas state, Ocosingo municipality, Ejido Boca de Chajul, 29.V.88, San Martín 839, on wood in evergreen tropical rain forest (ITCV;JDR); Chancalá, Rio Chancalá, Alt 100 m., 12.23.85, Chacón-Zapata 3346, on wood in evergreen tropical rain forest (XAL). Quintana Roo state, Othón P. Blanco municipality, Ejido La Unión, IX.87, San Martín 313, on wood in median subdeciduous tropical rain forest (ITCV;JDR); San Felipe Bacalar, 10.XI.88, San Martín 1219 and 1233 (CULTURED), on wood in an acahual (ITCV;JDR). Tamaulipas state, Ocampo municipality, 16.V.88, San Martín 663, on wood in low subdeciduous tropical rain forest (ITCV;JDR). Veracruz state, Catemaco municipality, "Los Tuxtlas" UNAM Biological Station, 4.XI.88, San Martín 1264, on wood in evergreen tropical rain forest (ITCV;JDR).

NOTES: Mexican material matches the concept of Dennis (1957) for *C. labellum*. The *Xylocladium* anamorph supports the hypothesis that the remaining members of the genus *Camillea* for which the anamorphs have not yet been obtained, will likewise have a *Xylocladium* state.

Camillea magnifica sp. nov. Figs. 3-5, 32-35

Stromata erumpentia, applanata, circularia vel irregularia, restricta, 0.2-3.4 cm longa x 0.15-1.4 cm lata x 0.7-0.8 mm alta, marginibus sterilibus aliquantum elevatis; extus brunneola vel nigella; intus nigella. Textura dura. Perithecia ampulliformia, 0.7 mm alta x 0.3-0.4 mm lata. Ostiola indistincta vel subtiliter punctata vel parum papillata. Asci octospori, cylindrici, breviter stipitati, 185-210 μm longitudine tota x 9-10 μm crassi, partibus sporiferis 157-177 μm, annulo apicali in liquore iodata Melzeri immerso cyanescente, cupulato, magno, (12-)12.5-14(-14.5) μm alto x 5-6 μm lato. Paraphyses persistentes, septatae, longior quam asci, 4-6 μm latae. Ascosporae luteolae, unicellulares, ellipsoideo-inequilaterales vel plus minusve lunatae, extremis angustis vel acutis, sub lente subtiliter aspris, per SEM observatae punctato-reticulatae, (22-)23-33 x (7-)8-9 μm. Rima germinationis nulla.

Stromata erumpent, applanate, circular or irregular, restricted, 0.2-3.4 cm long x 0.15-1.4 cm broad x 0.7-0.8 mm high, with somewhat raised sterile margins; exterior brownish to black; interior blackish. Texture hard. Perithecia flask-shaped, 0.7 mm high x 0.3-0.4 mm broad. Ostioles obscure to finely punctate to slightly raised. Asci eight-spored, cylindrical, short-stipitate, 185-210 μm total length x 9-10 μm broad, the spore-bearing part 157-177 μm, with apical ring bluing in Melzer's iodine reagent, cup-shaped, massive, (12-)12.5-14(-14.5) μm high x 5-6 μm broad. Paraphyses persistent, septate, longer than asci, 4-6 μm broad. Ascospores yellowish, unicellular, ellipsoid-inequilateral to somewhat crescentic, with narrow to acute ends, finely roughened by LM, punctate-reticulate by SEM, (22-)23-33 x (7-)8-9 μm. Lacking germination slit.

SPECIMEN EXAMINED: Tamaulipas state, Gómez Farías town, no date, San Martín 258, on wood in median subdeciduous tropical rain forest (ITCV, HOLOTYPE; JDR;ISOTYPE).

NOTES: *Camillea magnifica* has ascospores in the size range of *C. gigaspora* (Massee) Laessøe, J. D. Rogers & Whalley but its ostioles are punctate instead of papillate on raised hemispherical elevations, and its apical ring is much larger, i.e., (12-)12.5-14(-14.5) μm high vs 4.5-6.5 μm high. The ascospore surface as seen by SEM is poroid-reticulate in both species [see ascospore ornamentation of *C. gigaspora* (as *Hypoxylon hemisphaericum* J. H. Miller) in Rogers, 1977]. See NOTES on *Camillea guzmanii* herein for differences between *C. guzmanii* and *C. magnifica*). The name *magnifica* refers to the large apical ascus ring.

Camillea mexicana sp. nov. Figs. 6-8, 36-39

Stromata erumpentia, applanata, ca 1 m longa x 7-10 cm lata x 0.4-0.5 mm alta, marginibus sterilibus; extus brunneola vel nigella; intus nigella. Textura dura. Perithecia oblonga, 0.4-0.5 mm diam. Ostiola subliter papillata, 2-4 disposita in depressionibus non profundis et saepe coalescentibus. Asci octospori, cylindrici, breviter stipitati, 104-119 μm longitudine tota x 6-6.5 μm crassi, partibus sporiferis 68-78 μm, annulo apicali in liquore iodata Melzeri immerso cyanescente, valde

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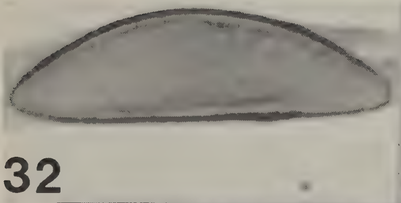
Figs. 32-39. *Camillea magnifica* and *C. mexicana*. 32-25. *C. magnifica*. 32. Ascospore, x 1240. 33. Ascus apical ring, x 1750. 34. Ascospore showing ornamentation, x 3500. 35. Detail of ascospore ornamentation, x 11000. 36-39. *C. mexicana*. 36. Ascospore, x 23000. 37. Ascus apical ring, x 1625. 38. Ascospore showing ornamentation, x 8000. 39. Detail of ascospore ornamentation, x 15000.

Figs. 32 and 36 by DIC. Figs. 33 and 37 by BF. Figs. 34, 35, 38, 39 by SEM. Figs. 32 and 36 from water mounts. Figs. 33 and 37 from mounts in Melzer's reagent.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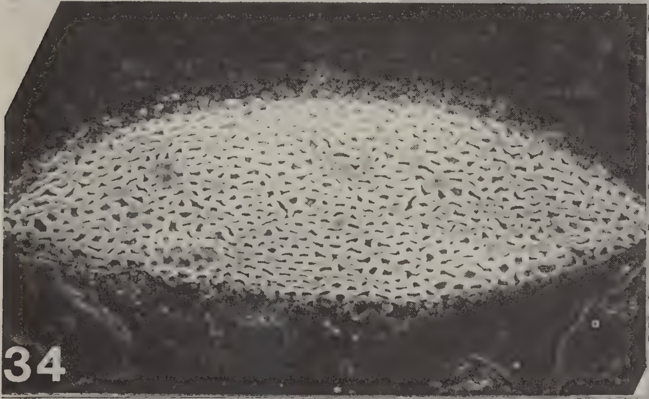
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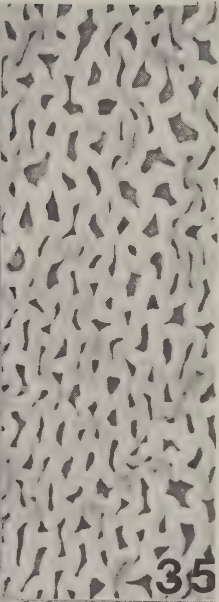
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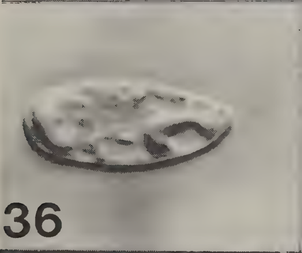
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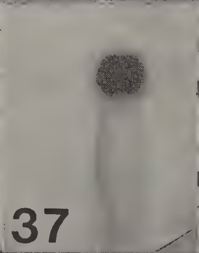
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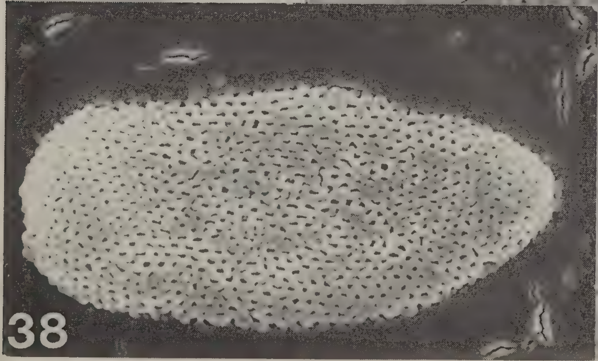
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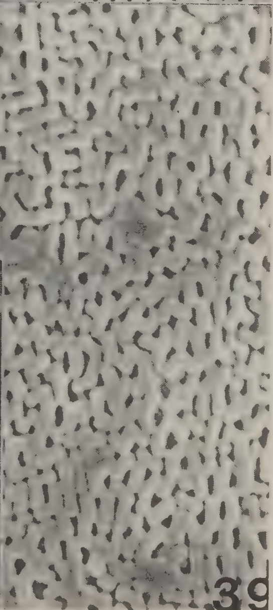
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rhombeo, 3 μm alto x 4 μm lato. Paraphyses persistentes, septatae, 7-10 μm latae. Ascosporae hyalinae vel luteolae, unicellulares, plus minusve oblongae, extremo saepe devexo, sub lente laeves, per SEM observatae plus minusve punctato-reticulatae, 9-11 x 4-5 μm. Rima germinationis nulla.

Stromata erumpent, applanate, ca. 1 m long x 7-10 cm broad x 0.4-0.5 mm high, with sterile margins; exterior brownish to blackish; interior blackish. Perithecia oblong, 0.4-0.5 mm diam. Ostioles finely papillate, in groups of 2-4 in shallow depressions which frequently coalesce. Asci 8-spored, cylindrical, short-stipitate, 104-119 μm total length x 6-6.5 μm broad, the spore-bearing part 68-78 μm, with apical ring bluing in Melzer's iodine reagent, strongly rhomboid, 3 μm high x 4 μm broad. Paraphyses persistent, septate, 7-10 μm broad. Ascospores hyaline to pale yellow, unicellular, more or less rectangular, often sloping at one end, smooth by light microscopy, more or less punctate-reticulate by SEM, 9-11 x 4-5 μm. Lacking germination slit.

SPECIMEN EXAMINED: Chipas State, Ocosingo municipality, "Montes Azules" Biosphere Reserve, 29.V.88, San Martín 856, on wood in evergreen tropical rain forest (ITCV,HOLOTYPE;JDR,ISOTYPE).

NOTES: *Camillea mexicana* differs from *C. fossulata* (Mont.) Laessøe, J. D. Rogers & Whalley in having a stromatal surface that is blackish or brownish-black instead shiny-black, in its faint, more indefinite surface depressions which tend to coalesce rather than remaining separate, in having several ostioles per depression, in having slightly larger ascospores, i.e. 9-11 x 4-5 μm vs (7.5-)8-9(-10) x 4-4.5(-5) μm, and in having unique interlocked, puzzle-like ascospore ornamentation as seen by SEM rather than poroid-reticulate [see description of *C. fossulata* in Miller, 1961, (as *Hypoxylon fossulatum* Mont.), and herein].

Camillea mexicana approximates *Camillea flosculosa* (Starb.) Laessøe, J. D. Rogers & Whalley in the disposition of the ostioles and ascospore morphology seen by LM, but differs in having smaller ascospores, i.e. 9-11 x 4-5 μm vs 11-15.5 x 5-6.5 μm, and in having the ascospore ornamentation referred to above instead of poroid-reticulate [see Rogers, 1977, for description of ascospore ornamentation in *Hypoxylon flosculosum* (Starb.) J. H. Miller]. The Mexican fungus shares with *Camillea punctulata* (Berk. & Ravenel) Laessøe, J. D. Rogers & Whalley the shape of the ascospores and to a lesser degree the ascospore ornamentation, but the latter species has pitted ostioles instead of slightly papillate ones in faint depressions.

This highly distinctive fungus seems to have a transitional type of ascospore ornamentation from poroid reticulate to ribbed anastomosing, or vice versa.

Camillea mucronata Mont., Ann. Sci. Nat. Bot. 4:112. 1855.

Teleomorph is as described by Medel & Chacón (1988), and Laessøe *et al.* (1989).

SPECIMEN EXAMINED: Chacón-Zapata 3316, 22.XII.85, Michol-Ha falls, Palenque municipality, Chiapas state, on wood in evergreen tropical rain forest (XAL).

NOTES: Medel & Chacón (1988) reported the species from the Mexican state of Chiapas.

It is interesting to note that, with one exception, material of *C. mucronata* so far reported was collected near rivers, suggesting that the species is confined to some tropical, riparian host(s) (see Laessøe *et al.* 1989 for distribution of *C. mucronata*).

Camillea obularia (Fr.) Laessøe, J. D. Rogers & Lodge, Mycologia 83:224. 1991.
Camillea broomeiana (Berk. & M. A. Curtis) Laessøe, Rogers & Whalley, Myc. Res. 93:149. 1989.

Teleomorph is as described in Laessøe *et al.* (1989) under *C. broomeiana*; the anamorph was described in Rogers (1975a) [as *Nummularia broomeiana* (Berk. & M. A. Curtis) J. H. Miller].

SPECIMENS EXAMINED: Oaxaca state, Km 65 Loma Bonita-Sayula off-side road, 21.V.88, San Martín 719, on wood of *Delonix regia* (Bojer ex Hook) Raf., ("flambollán"), (ITCV;JDR). Tamaulipas state, Gómez Farías town, 17.I.85, García J. 4599, on wood of *Mangifera indica* L. ("mango"), in an orchard (ITCV;JDR).

NOTES: Mexican material fits well the species concept of *C. obularia*. It is interesting to note that out of 3 collections made by F. C. Deighton in Sierra Leone, one was on *Delonix regia* and the other on *Mangifera indica* (see Laessøe, *et al.*, 1989). Mexican material was found on those hosts (see SPECIMENS EXAMINED above).

Camillea punctulata (Berk. & Ravenel) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:143. 1989.

The teleomorph was as described by Miller (1961), and the anamorph was described by Jong & Rogers (1972) [as *Hypoxylon punctulatum* (Berk. & Ravenel) Cooke in both publications].

SPECIMENS EXAMINED: Chiapas state, La Trinitaria municipality, Montebello Lagoons, 50 km from the Guatemalan border, 24.V.88, San Martín 789, on wood in pine-oak forest (ITCV;JDR). Nuevo León state, Santiago municipality, El Cercado, VIII.1987, San Martín 395, on wood of *Quercus ryzophylla* Weath. in submontane scrub with *Quercus* spp. (ITCV;JDR). Tamaulipas state, Gómez Farías municipality, Malacate, 31.III.88, Baldazo 219, on wood of *Quercus* aff. *germana* Cham. & Schlecht. in cloud forest (ITCV;JDR).

NOTES: This species seems to be confined almost exclusively to *Quercus* spp. (Barnett, 1957; Jong & Rogers, 1972). Its ascospore shape and ornamentation by SEM approximates that of *Camillea mexicana* described above, but the ascospores of the latter are larger and its ostioles are not in pits [see description of ascospore surface of *H. punctulatum* in Rogers (1977), and description of *C. mexicana* herein].

Medel *et al.* (1989) reported this species [as *Hypoxylon punctulatum* (Berk. & Ravenel) Cooke] from the Mexican state of Veracruz growing on wood in a cloud forest.

Camillea stellata Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:144. 1989.

Teleomorph is as described in Laessøe *et al.* (1989).

SPECIMENS EXAMINED: Chiapas state, Palenque municipality, Palenque Ruins, IX.1987, San Martín 296, on wood in evergreen tropical rain forest (ITCV;JDR). Quintana Roo state, Othón P. Blanco municipality, Ejido La Unión, 8.XII.86, San Martín 37, on wood in median subdeciduous tropical rain forest (ITCV;JDR).

NOTES: Mexican material seems to be typical of the species even though it has few ascospores in good condition.

Camillea tinctor (Berk.) Laessøe, J. D. Rogers & Whalley, Myc. Res. 93:145. 1989.

Teleomorph and anamorph are more or less as described by Laessøe *et al.* (1989).

SPECIMENS EXAMINED: Chiapas state, Ocosingo municipality, Montes Azules Biosphere Reserve, 27.V.88, San Martín 830, on wood in evergreen tropical rain forest (ITCV;JDR); Palenque municipality, Palenque Ruins, 2.VI.88, San Martín 876, on wood in evergreen tropical rain forest (ITCV;JDR). Nuevo León state, Santiago municipality, El Cercado, 26.V.88, Moreno 221 and 225, on wood in submontane scrub with *Quercus* spp. (ITCV;JDR); 23.X.88, San Martín 1146, (same data as Moreno 221 and 225 above); 29.I.89, Moreno 267 (CULTURED), on wood of *Morus nigra* L. ("mora"), in submontane scrub with *Quercus* spp., (ITCV;JDR). Tamaulipas state, Gómez Farías municipality, "El Nacimiento", 29.V.88, San Martín 620, on wood in median subdeciduous tropical rain forest (ITCV;JDR); Hidalgo municipality, Ejido Los Mimbres, "Los Alamos", 7.VII.87, San Martín 200, on wood of *Platanus* sp., on a river bank (ITCV;JDR). Veracruz state, Jalapa Enriquez municipality, "Francisco Javier Clavijero" Botanical Garden, VIII.87, San Martín 620 A, on wood in cloud forest (ITCV;JDR); San Andrés Tuxtla municipality, Eyipantla falls, 5.XI.88, San Martín 1339 (CULTURED), on wood of a riparian tree (ITCV;JDR).

NOTES: Mexican material does not always impart an orange stain to the wood beneath stromata; perithecial size is variable, i.e., in Moreno 225 they measure 0.2-0.3 mm broad and in San Martín 620 "A" they measure 0.6-0.7 mm; ascospore size is variable among collections, i.e., in Moreno 267 the range is 13-17 μm while in San Martín 1339 it is 18-20(-21) μm; ascospores of Moreno 267 readily germinated in water and produced germ tubes at one or both ends of the propagules, even when stromata lacked asci and thus appeared old.

Anamorphic features are variable as well, i.e., San Martín 1339 produced conidia highly variable in size, 6-18 x (1.5-)2-3(-3.5) μm, and Moreno 267 produced ampullae not as broad as in "typical" isolates, and *Nodulisporium*-type conidiophores were more common than in other isolates. It appears necessary to obtain additional fresh collections of this species and study the teleomorphic and anamorphic features in order to assess its limits.

Camillea cf. *verruculospora* J. D. Rogers, Laessøe & Lodge, Mycologia 83:224. 1991.

The teleomorph is as described by Rogers *et al.* (1991), except that ascospores of Mexican material are smaller, i.e., (9-)10-11(-12) x 4-5 μm vs (11-)12-13.5 x 4.5-5(-6.5) μm.

SPECIMEN EXAMINED: Chiapas state, Ocosingo municipality, Ejido Boca de Chajul, 29.V.88, San Martín 837, on wood in an acahual (ITCV;JDR).

NOTES: The Mexican collection is probably not fully mature. This might account for the spores being smaller than usually encountered.

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LITERATURE CITED

Barnett, H. L. 1957. *Hypoxylon punctulatum* and its conidial stage on dead oak trees and in culture. Mycologia 49:588-595.

Callan, B. E. and J. D. Rogers. 1990. Teleomorph-anamorph connections and correlations in some *Xylaria* species. Mycotaxon 36:343-369.

Dennis, R. W. G. 1957. Further notes on tropical American Xylariaceae. Kew. Bull. 1957. 297-332.

Glawe, D. A. and J. D. Rogers. 1986. Conidial states of some species of Diatrypaceae and Xylariaceae. Can. J. Bot. 64:1493-1498.

Holmgren, R. K., N. H. Holmgren, and L. C. Barnett. 1990. Index Herbariorum. Part I: The herbaria of the world. Ed. 8. New York Botanical Garden. 693 p.

INEGI. 1983. Síntesis Geográfica y Nomenclators de los estados de Coahuila, Morelos, Nuevo León y Tamaulipas. Secretaría de Programación y Presupuesto. México.

INEGI. 1988. Carta Topográfica de México 1:250 000. Secretaría de Programación y Presupuesto. México.

Jong, S. C., and J. D. Rogers. 1972. Illustrations and descriptions of conidial states of some *Hypoxylon* species. Wash. State Agric. Exp. Sta. Bull. 71. 51 p.

Ju, Y.-M. 1990. Studies of Xylariaceae from Taiwan. M. Sc. Thesis. Washington State University, Pullman, WA. 171 p.

Koeppen, W. 1948. Climatología. Fondo de Cultura Económica. México, D.F. 478 p.

Laessøe, T., J. D. Rogers, and A. J. S. Whalley. 1989. *Camillea, Jongiella* and light-spored species of *Hypoxylon*. Myc. Res. 93:121-155.

Martin, P. 1969. Studies in the Xylariaceae: VI. *Daldinia, Numulariola* and their allies. J. S. African Bot. 35:267-320.

Medel, R. and S. Chacón. 1988. Ascomycetes lignicolas de México, II. Algunos Pyrenomycetes y Discomycetes. Micologia Neotropical Aplicada 1:87-96.

Medel, R., S. Chacón, and G. Guzmán. 1989. Especies conocidas y nuevos registros de *Hypoxylon* (Sphaeriales, Xylariaceae) en México. Rev. Mex. Mic. 5:149-168.

Miller, J. H. 1961. A monograph of the world species of *Hypoxylon*. Univ. Georgia Press, Athens. 158 p.

Pérez-Silva, E. 1983. Distribución de algunas especies del género *Hypoxylon* (Pyrenomycetes) en México. An. Inst. Biol. Univ. Nac. Aut. Méx. 54:1-22.

Petrini, L. E. and E. Müller. 1986. Haupt- und nebenfruchtformen europäischer *Hypoxylon*-Arten (Xylariaceae, Sphaeriales) und verwandter pilze. Mycologia Helv. 1:501-627.

Pouzar, Z. 1979. Notes on taxonomy and nomenclature of *Nummularia* (Pyrenomycetes). Ceská Mykologie. 33:207-219.

Rogers, J. D. 1975a. *Nummularia broomeiana*: conidial state and taxonomic aspects. Am. J. Bot. 62:761-764.

Rogers, J. D. 1975b. The ascospore of *Hypoxylon glycyrrhiza*. Mycologia 67:657-662.

Rogers, J. D. 1977. Surface features of the light-colored ascospores of some applanate *Hypoxylon* species. Can. J. Bot. 55:2394-2398.

Rogers, J. D. and K. P. Dumont. 1979. Los hongos de Colombia VI. Two new applanate species of *Hypoxylon*. Mycologia 71:807-810.

Rogers, J. D., T. Laessøe and J. Lodge. 1991. *Camillea*: New combinations and a new species. Mycologia 83:224-227.

Rzedowski, J. 1978. La vegetación de México. Ed. LIMUSA. México. 431 p.

San Martín, F. and J. D. Rogers. 1989. A preliminary account of *Xylaria* of México. Mycotaxon 34:283-373.

Welden, A. L. and G. Guzmán. 1978. Lista preliminar de los hongos, líquenes y myxomycetos de las regiones de Uxpanapam, Coatzacoalcos, Los Tuxtlas, Papaloapan y Xalapa (Parte de los estados de Veracruz y Oaxaca). Bol. Soc. Mex. Mic. 12:59-102.

APPENDIX

Location of Collecting Sites

For the exact location of the sites where the field work was conducted, the Atlas de México and the Geographical Syntheses and Nomenclators of the pertinent states, edited by the Instituto Nacional de Geografía y Estadística (INEGI, 1983, 1988) were consulted. The main locations are listed below.

A. Campeche state:

1) Escárcega municipality, Ing. Eduardo Sangri Serrano Forestry Experimental Station, 18° 40' Lat; 90° 45' Long; Topographic Map E15-6.

B. Chiapas state:

1) Ejido Boca de Chajul, 16° 07' Lat; 99° 52' Long; Topographic Map E1512;D153.
2) Ejido Pico de Oro, 16° 20' Lat; 90° 45' Long; Topographic Map E152;D153.
3) El Huitepec Hill, 16° 45' Lat; 92° 43' Long; 2750 m Alt; Topographic Map E1511.
4) El Triunfo Hill, 15° 40' Lat; 112° 48' Long; 2450 m Alt; Topographic Map D15-2.
5) Malpaso Dam, 16° 48' Lat; 93° 20' Long; Topographic Map E-15-11.
6) Montebello Lagoons, 16° 08' Lat; 91° 42' Long; Topographic Map E1512;D153.
7) Palenque Ruins, 17° 30' Lat; 92° 01' Long; Topographic Map E-15-9.

C. Coahuila state:

1) Arteaga Municipality, San Antonio de las Alazanas, 25° 16’ Lat; 10° 34’ Long; Topographic Map G14-C35.

D. Federal District:

1) Km 43 Mexico-Cuernavaca Road, 19° 02’ Lat; 99° 12’ Long; Topographic Map E-14-2.

E. Jalisco state:

1) Cacoma Mountains, 19° 58’ Lat; 104° 32’ Long; Topographic Map E-13-2-5.
2) Guadalajara City, 20° 39’ Lat; 103° 18’ Long; 1550 m Alt; Topographic Map F-13-12.
3) La Manzanilla, 20° 00’ Lat; 103° 09’ Long; 2050 m Alt; Topographic Map F13-12.
4) Manantlán Biosphere Reserve, 19° 37’ Lat; 104° 13’ Long; Topographic Map E-13-2-5.
5) Mazamitla, 19° 55’ Lat; 103° 01’ Long; Topographic Map E-13-3.
6) Tecalitlán, 19° 28’ Lat; 103° 18’ Long; 1140 m Alt; Topographic Map E13-3.

F. Morelos state:

1) La Pera Curve, 25° 14’ Lat; 99° 14’ Long; Topographic Map E14-A59.

G. Nuevo León state:

1) El Chipinque, 25° 55’ Lat; 100° 22’ Long; Topographic Map G-14-C15.
2) El Cercado, 25° 24’ Lat; 100° 08’ Long; Topographic Map G14-C36.
3) El Salto, La Ciénega, 25° 22’ Lat; 100° 14’ Long; Topographic Map G14-C36.
4) Guadalupe City, 25° 40’ Lat; 100° 15’ Long; Topographic Map G14-C26.
5) La Encantada, 23° 49’ Lat; 99° 41’ Long; Topographic Map F14-A17.
6) San Roque, 25° 36’ Lat; 100° 09’ Long; Topographic Map G14-C26.

H. Oaxaca:

1) Temazcal, 18° 15’ Lat; 96° 21’ Long; Topographic Map E14-6.
2) Teotitlán del Camino, 18° 08’ Lat; 96° 53’ Long; Topographic Map E14-6.

I. Quintana Roo state:

1) Ejido La Unión, 17° 55’ Lat; 88° 52’ Long; Topographic Map E16-4-7.
2) Km 12 Cafetal-Mahahual Road, 18° 47’ Lat; 87° 45’ Long; Topographic Map E16-2-5.
3) La Noria Ranch, 19° 40’ Lat; 88° 44’ Long; Topographic Map E16-1.
4) San Felipe Bacalar, 18° 40’ Lat; 88° 25’ Long; Topographic Map E16-4-7.
5) Tamalcab Island, 18° 35’ Lat; 88° 13’ Long; Topographic Map E16-4-7.

J. San Luis Potosí state:

1) Tamasopo Bath Resort, 21° 50’ Lat; 99° 25’ Long; Topographic Map F14-8.

K. Tabasco state:

1) Colegio Superior de Agricultura Tropical, 17° 59’ Lat; 93° 35’ Long; Topographic Map E15-8.
2) La Venta Archaeological Zone, 18° 05’ Lat; 94° 03’ Long; Topographic Map E15-1-4.

L. Tamaulipas state:

1) Alta Cima, 23° 03’ Lat; 99° 12’ Long; Topographic Map F14-A49.
2) Barra del Tordo, 23° 03’ Lat; 97° 45’ Long; Topographic Map F14-B44.
3) Ejido Conrado Castillo, 23° 57’ Lat; 99° 28’ Long; Topographic Map F14-A18.
4) Ejido Julilo, 23° 08’ Lat; 99° 12’ Long; Topographic Map F14-A49.
5) El Bernal Hill, 22° 45’ Lat; 98° 35’ Long; Topographic Map F14-B52.
6) El Cielo Ranch, 23° 05’ Lat; 99° 11’ Long; Topographic Map F14-A49.
7) El Madroño, 23° 36’ Lat; 99° 13’ Long; Topographic Map F14-A29.
8) El Tigre Hill, 24° 37’ Lat; 98° 37’ Long; Topographic Map G14-D62.
9) Gómez Farías town, 23° 02’ Lat; 99° 09’ Long: Topographic Map F14-A49.
10) Km 2 Victoria City-Matamoros City Road, 22° 02’ Lat; 99° 08’ Long; Topographic Map F14-A19.
11) La Libertad, 23° 47’ Lat; 99° 11’ Long; Topographic Map F14-A19.

M. Veracruz state:

1) Axocoapan, 19° 12’ Lat; 97° 00’ Long; Topographic Map E14-3.

2) Eyipantla Falls, 18° 25' Lat; 95° 13' Long; Topographic Map E15-1-4.
3) Jalapa, 19° 32' Lat; 96° 55' Long; 1440 m Alt; Topographic Map E14-3.
4) Los Tuxtlas UNAM Biological Station, 18° 33' Lat; 95° 04' Long; Topographic Map E15-1-4.

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NEW FUNGI FROM YUCCA: PLANISTROMELLA YUCCIFOLIORUM, GEN. ET SP. NOV., ITS ANAMORPH, KELLERMANIA YUCCIFOLIORUM, SP. NOV., AND PLANISTROMELLA UNISEPTATA, SP. NOV., THE TELEOMORPH OF KELLERMANIA YUCCIGENA

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Planistromella, a new genus closely related to *Planistroma*, is described. The anamorph of *Planistromella yuccifoliorum* is *Kellermania yuccifoliorum*, a new species. The anamorph of *Planistromella uniseptata* is *Kellermania yuccigena.*

Key words: Loculoascomycete, Coelomycete, *Planistromella, Kellermania.*

INTRODUCTION

Stagonospora gigantea Heald & Wolf (3) was described from *Agave americana* Linnaeus, and has been reported from several species of *Yucca* in the United States (2). The name has been a catch-all designation for coelomycetes from *Yucca* which have unappendaged, large, hyaline, septate conidia born singly on conidiogenous cells lining a thick-walled pycnidial chamber, because there were no other satisfactory described genera for their disposition. The type of *S. gigantea* was examined (10), and *Piptarthron uniloculare* Ramaley was established to accommodate some of the fungi formerly called *S. gigantea.* Further study and collections indicate that another anamorph species can be reliably separated from the fungi placed in *S. gigantea* for lack of an alternative taxon. This new anamorph, *Kellermania yuccifoliorum* Ramaley, has finger-shaped, 2-septate, somewhat pointed conidia that often have a small apical appendage. The teleomorphs of *K. yuccifoliorum* and *K. yuccigena* Ellis & Everhart comprise a new ascomycete genus, *Planistromella*, which has septate ascospores but otherwise resembles *Planistroma*, the teleomorph for the *Piptarthron* species in which a teleomorph has been observed (9, 10, and unpublished).

MATERIAL and METHODS

Lactophenol-cotton blue was utilized when necessary in the study of appendage formation during conidiogenesis.

Cultures were obtained by suspending freshly extruded conidia in a drop of sterile tap water and spreading the drop over the surface of commercial potato dextrose agar (PDA) in a petri plate. Germinating conidia were isolated onto plates of fresh PDA and grown at room temperature in incident light. Asci were washed 3 times in sterile tap water and placed on petri plates of PDA. Growth was isolated onto petri plates of fresh PDA and grown at room temperature in incident light.

Planistromella yuccifoliorum Ramaley and *Kellermania yuccifoliorum* Ramaley were discovered among specimens in a loan from the University of California at Berkeley (UC). Fresh *K. yuccifoliorum* was collected subsequently from the desert of the southwestern United States at eleven sites from Washington County, Utah, southward to San Bernardino and Riverside Counties, California, and Cocconino County, Arizona, on *Yucca baccata* Torrey, *Y. brevifolia* Engelmann, and *Y. thornberi* McKelvey.

Measurements were made of fungal tissue mounted in sterile tap water. Ten conidia were measured from one conidioma on each of five leaves in the eleven fresh collections. Material in two of the herbarium specimens was very limited, so only twenty-five conidia for each of those two specimens (UC 1138875, UC 1202973) were measured. An analysis of variance (ANOVA) of conidial width for all groups was prepared. The sum of squares simultaneous test procedure (SS-STP) was carried out for: (a) all collections, (b) fresh vs herbarium collections, (c) all fresh collections, (d) fresh collections from *Y. brevifolia* vs those from other *Yucca* species, and (e) fresh collections from *Y. brevifolia* only (Table 1) to test the significance of differences in mean conidial width for these groups.

TAXONOMY

PLANISTROMELLA Ramaley, *gen. nov.*

Stromata atrocolorata, subepidermalia, immersa, erumpentia, separata vel confluentia, glabra; paries crassus, cupulatus, pars supera in epidermide hospitis affixa, ex aliquot stratis cellularum atroparietum compositus. Stratum supremum stromatis ex columnis cellularum elongatarum compositum. Loculi ascogeni in eodem stromate ac loculi conidiogeni vel spermatiogeni vel ambo exorientes. Loculi ovoidei vel globosi, unistrati, textura interthecio repleti, omnes ostiolati periphysibus, per columnas ex cellulis elongatis compositis separati. Asci bitunicati, subclavati vel prope cylindrati. Ascosporae leves, hyalinae, septatae.

Typus generis: Planistromella yuccifoliorum Ramaley

Stromata dark, subepidermal, immersed, erumpent, separate or confluent, glabrous; wall thick, cup-shaped, upper portion attached to the host epidermis, composed of several layers of dark-walled cells. The top of a stroma composed of columns of elongated cells. Ascogenous locules developing in the same stroma as the conidial or spermatial locules or both. Locules ovoid to globose, in a single layer, filled with abundant interthecial tissue, each with a periphysate ostiole, separated by columns of elongated cells. Asci bitunicate, slightly clavate or nearly cylindric. Ascospores smooth, hyaline, septate.

Planistromella yuccifoliorum Ramaley *sp. nov.*-----Fig. 1, 2, A & C.

Stromata fusca vel atra, subepidermalia, immersa, erumpentia, amphigena, separata vel confluentia, glabra, 300-550 μm diam ubi separata, usque ad 450 μm elata, 1-5 locularia; paries crassus, cupulatus, pars supera in epidermide hospitis affixa, ex 6-12 stratis cellularum atroparietum compositus. Stratum supremum stromatis ex columnis cellularum elongatarum compositum. Loculi ascogeni in eodem stromate ac loculi conidiogeni vel spermatiogeni vel ambo exorientes, asci post conidia vel spermatia vel ambo formati. Loculi ovoidei vel globosi, unistrati, omnes ostiolati periphysibus, per columnas ex cellulis brunneis, elongatis, aliquantum crassiparietibus compositis separati. Asci bitunicati, subclavati, octospori, 120 x 32 μm ante prolationem ultimam et missionem ascosporarum. Ascosporae hyalinae, ellipsoideae aspectu uno, curvatae extremis obtuse rotundatis ubi 90 gradibus versae, 2-septatae, 34-42 x 10-16 μm. Textura interthecii abunda, filamentosa, copiosa ubi asci vetissimi maturi, fatiscens ab apice loculi versus imum.

Stromata (Fig. 2, A) dark brown to black, subepidermal, immersed, erumpent, amphigenous, separate or confluent, glabrous 300-550 μm diam when separate, up to 450 μm tall, 1-5 loculate; wall thick, cup-shaped, the upper part attached to the host epidermis, composed of 6-12 layers of dark-walled cells. The top of a stroma composed of columns of elongated cells. Ascogenous locules developing in the same stroma as a conidiogenous or spermatiogenous locule or both, asci formed after the production of conidia or spermatia or both. Locules (Fig. 1) ovoid to globose, in a single layer, each with a periphysate ostiole, separated by columns of brown, rather thick-walled, elongated cells. Asci (Fig. 2, C) bitunicate, slightly clavate, 8-spored, 120 x 32 μm before the final elongation and ascospore release. Ascospores (Fig. 2, C) hyaline, ellipsoid in one view, curved with bluntly rounded ends when rotated 90 degrees, 2-septate, 34-42 x 10-16 μm. Interthecial tissue abundant, filamentous, present in large quantity when the oldest asci are mature, breaking down at the top of the locule and proceeding downward.

Substrate: Leaves of *Yucca* species.

HOLOTYPE: USA. CALIFORNIA: San Bernardino County, Roadside 20 miles east of Baker (Hwy. 91/466), on leaves of *Yucca brevifolia* Engelmann, 14 April 1960, Isabelle Tavares No. 466, UC 1202973.

The collection of this fungus was more than thirty years old, so cultivation was

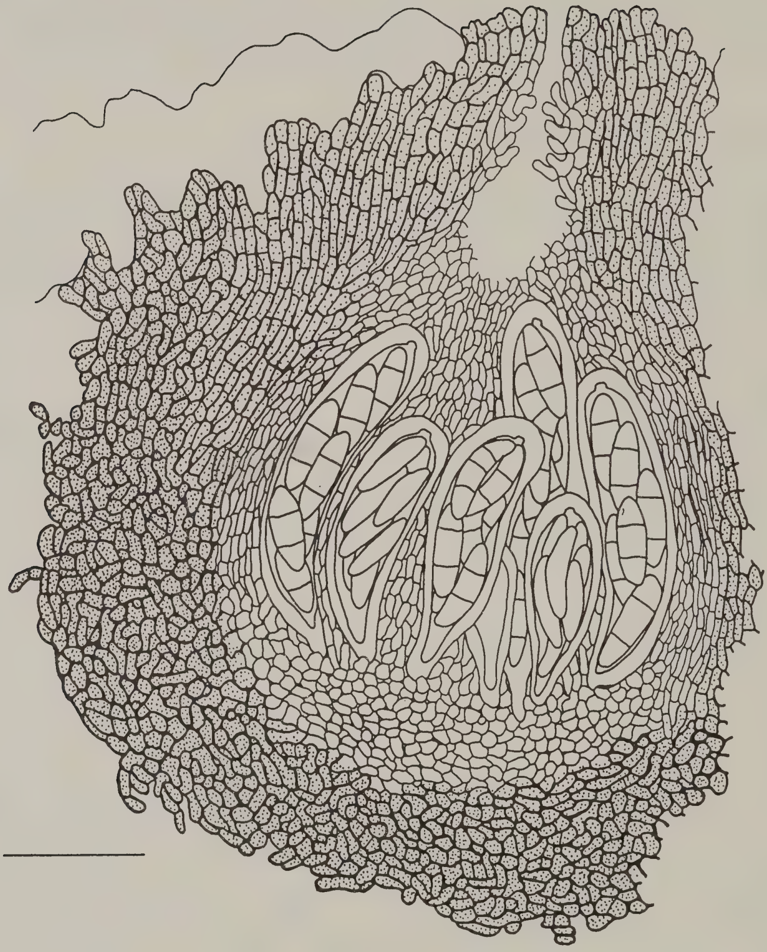

Fig. 1. *Planistromella yuccifoliorum,* detail of an ascoma. Standard line = 50 μm.

not possible. Only dead tissues were available for measurement. In the living state, the ascospores and asci could be expected to be larger than the above measurements--up to 18% longer and 25% wider for the ascospores, and up to 20% longer and 26% wider for the asci (1).

Anamorph: ***Kellermania yuccifoliorum*** Ramaley *sp. nov.*-----Fig. 3, A-D, Fig. 4, A & B.

Conidiomata amphigena, subepidermalia, atra, immersa, erumpentia etiam obtecta in margine per epidermidem, separata vel confluentia, glabra, 250-600 (-800) μm diam ubi separata, usque ad 600 μm elata, unilocularia, ostiolata; paries crassus, cupulatus, in epidermide hospitis affixus, ex 6-12 stratis cellularum atrorum crassiparietum compositus, pallidior versus partem interiorem, et 2-4 stratis cellularum hyalinarum. Stratum supremum conidiomatis ex columnis cellularum aurearum elongatarum compositum. Ostiolum cellulis atriparietibus cinctum, per rumpentem vel disrumpentem epidermidis hospitis in margine interiore parietis cupulati expositum. Ontogenesis conidiorum holoblastica. Conidiophora carentia. Cellulae macroconidiogenae in parietibus lateralibus et basalibus conidiomatis formatae, brevicylindratae, hyalinae, leves, omnes conidium unum acrogenum formantes. Macroconidia anguste ellipsoidea-cylindrata, extremis basalibus obtuse rotundatis, apicibus acutis et appendicibus usque ad 5 μm longis superpositis, plerumque 2-septata, 50-100 x (8-)13-14(-16) μm. Cellulae microconidiogenae in pariete supero conidiomatis et canale ostioli exorientes. Microconidia acrogena, plus minusve cylindrata, septata, levia, hyalina, 5-10 x 2.5-4 μm. Spermatia in loculo centrali stromatis, cum vel sine conidiis, vel in uno vel plus loculis in columnis verticalibus abundantibus cellularum elongatarum ad parietes laterales aliquot conidiomatum affixis formata, omnis loculus ostiolatus vel loculi coalescentes et ostiolum solitarium formantes. Cellulae spermatiogenae discretae vel integratae in conidiophoro unicellulario, cylindratae vel elongatae-conicae, phialidicae, 8-16 x 2-3.5 μm. Spermatia bacillaria, hyalina, aseptata, levia, 3-7 x 1.6-2.5 μm.

Conidiomata (Fig. 3, A) amphigenous, subepidermal, dark, immersed, erumpent but a rim remaining covered by the epidermis, separate or confluent, glabrous 250-600 (-800) μm diam when separate, up to 600 μm tall, unilocular, ostiolate; wall thick, cup-shaped, attached to the host epidermis, composed of 6-12 layers of dark, thick-walled cells, lighter toward the interior, and 2-4 layers of hyaline cells. The top layer of a conidioma composed of vertical columns of golden elongated cells. Ostiole surrounded by dark-walled cells, exposed by rupture or breaking away of the host epidermis at the inner edge of the cup-shaped wall. Conidiogenesis holoblastic. Conidiophores absent. Macroconidiogenous cells (Figs. 3, A; 4, A) formed on lateral and basal walls of a conidioma, short-cylindric, hyaline, smooth, each forming a single acrogenous conidium. Macroconidia (Fig. 4, B) narrowly ellipsoid-cylindric, the base bluntly rounded, the apex more pointed and often surmounted by an appendage up to 5 μm long, mostly 2-septate, 50-100 x (8-)13-14(-16) μm. Microconidiogenous cells arising on the upper wall of a conidioma and in the ostiolar channel. Microconidia acrogenous, more or less cylindric, aseptate, smooth-walled, hyaline 5-10 x 2.5-4 μm (Fig. 3, B). Spermatia formed in the central locule of a stroma, with conidia or without, or in one or more locules in the abundant vertical columns of elongated cells attached to the lateral walls of some conidiomata (Fig. 3, D), each locule ostiolate or coalescing and forming one ostiole. Spermatiogenous cells discrete or integrated on a one-celled (usually) conidiophore (Fig. 3, C) cylindric to elongate-conical, phialidic, 8-16 x 2-3.5 μm. Spermatia bacillar, hyaline, smooth, 3-7 x 1.5-2.5 μm (Fig. 3, C).

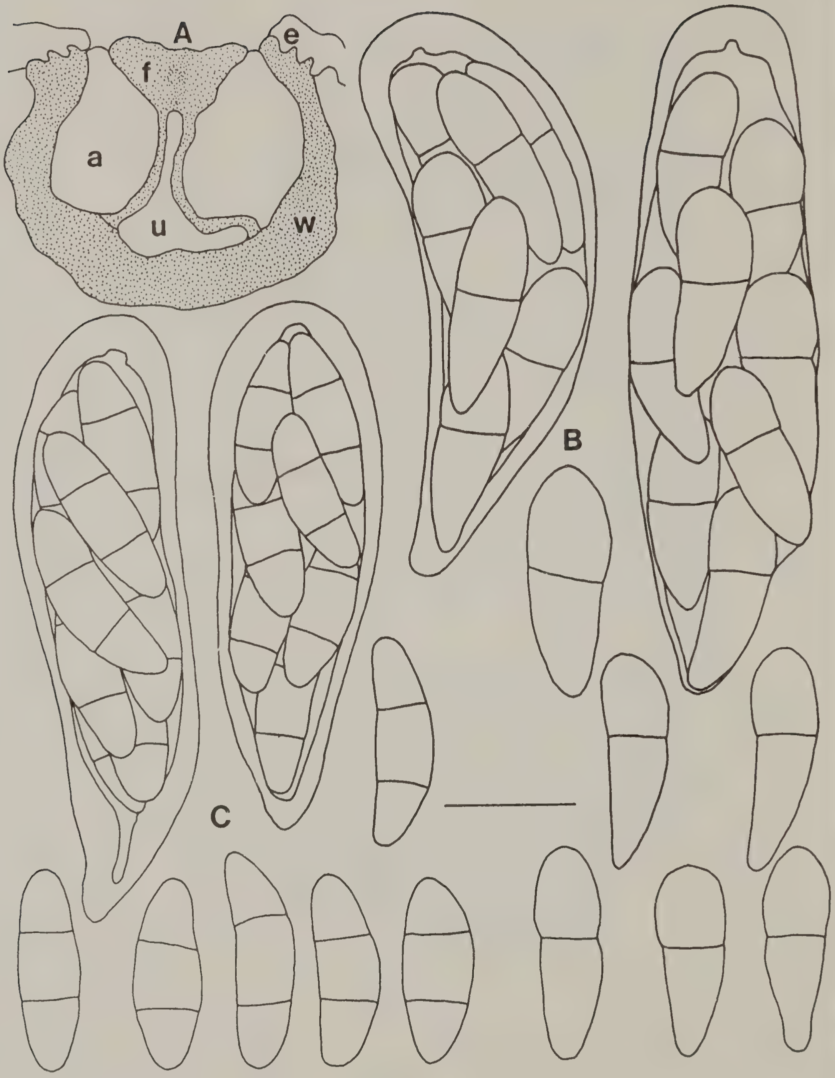

Fig. 2. A, C, *Planistromella yuccifoliorum.* A. Diagram of stroma with two ascomata sectioned. The left ascoma is drawn in detail in Figure 1; a=ascoma, e=host epidermis, f=columnar filamentous portion of stroma, u=collapsed locule which contained conidia or spermatia or both, w=wall. C. Asci and ascospores. B. *Planistromella uniseptata,* asci and ascospores. Standard line = A, 175 μm; B, C, 25 μm.

Substrate: Leaves of *Yucca* species.

HOLOTYPE: USA. ARIZONA: Mohave County, dirt road 0.3 miles from mile 20, Gem Acres Road turnoff from Highway 40, on leaves of *Yucca brevifolia* Engelmann, 15 April 1992, Annette Ramaley No. 9208, UC 1475101. Paratypes: (1) USA. CALIFORNIA: Los Angeles County, Claremont, Rancho Santa Ana Botanic Garden, leaves of *Yucca baccata* Torrey, 26 March 1957, Lee Bonar, UC 1138875; (2) USA. CALIFORNIA: San Bernardino County, roadside 20 miles east of Baker (Highway 91/466), on leaves of *Yucca brevifolia* Engelmann, Isabelle Tavares No. 466, 14 April 1960, UC 1202973; (3) USA. CALIFORNIA: Riverside County, near Cottonwood Springs, Joshua Tree National Monument, on *Yucca schidigera* Roezl *ex* Ortgies, 6 April 1952, Lee Bonar, UC 966401; (4) USA. ARIZONA: Santa Cruz County, mile 282.8 along Interstate Highway 10, leaves of *Yucca thornberi* McKelvey, 13 April 1992, Annette Ramaley No. 9211, UC 1475100; (5) USA. ARIZONA: Santa Cruz County, mile 283.6 along Interstate Highway 10, leaves of *Yucca thornberi* McKelvey, 13 April 1992, Annette Ramaley No. 9212, BPI 1112456; (6) USA. UTAH: Washington County, Visitor's Center, just over border from Arizona along Interstate 15, on leaves of *Yucca brevifolia* Engelmann, 15 April 1992, Annette Ramaley No. 9207, BPI 1112455.

Kellermania yuccifoliorum is distinguished from the other *Kellermania* species by conidial septation and the size of the apical appendage. *K. anomala* (Cooke) Höhnel (Fig. 4, C) and *K. yuccigena* (Fig. 4, E) conidia have long apical appendages (12-32 μm). However, appendages of *K. anomala* are often difficult to observe without phase optics, and may be absent entirely. They seem pliant, and are sometimes free from the conidia. *K. yuccifoliorum* conidia (Fig. 4, B) have a short apical appendage (up to 5 μm) when an apical appendage is present. *K. yuccigena* conidia regularly have one, approximately median septum. *K. anomala* conidia have two septa, and the middle cell is regularly shorter than either end cell. *K. yuccifoliorum* conidia have two septa, but the middle cell is generally longer than the end cells. However, *K. anomala* and *K. yuccifoliorum* conidia lacking an appendage may be indistinguishable if the middle cell length is atypical for the species (compare conidia in Fig. 4, B & C).

Conidia from the fresh collections germinated readily and formed colonies with white aerial, surface, and subsurface mycelium. The reverse of the colonies from some collections was pale pink, from others, white. The majority of the mycelium of colonies of most isolates soon became gray to nearly black. Within a month, conidiomata were formed that produced typical *K. yuccifoliorum* conidia. *Planistromella yuccifoliorum* could not be cultivated to confirm its connection with *K. yuccifoliorum.* The connection is circumstantial but assumed because (a) closely related taxa (9, 10) have similar teleomorph and anamorph phases; (b) many collections have been made throughout the range of the host, and the unilocular representatives of the *Kellermania-Piptarthron* complex now known from *Yucca brevifolia* are *P. uniloculare, K. yuccifoliorum,* and *K. anomala.* The teleomorph for *P. uniloculare*, *Planistroma obtusilunatum*

Ramaley, has been confirmed experimentally (10). Two stromata with a perfect state present were found in a collection in which *K. anomala* was the only unilocular *Kellermania-Piptarthron* representative . A single ascus with mature ascospores was available. The ascospores were approximately medianly 1-septate; (c) *K. yuccifoliorum* was the only unilocular representative of the *Kellermania-Piptarthron* complex present in the collection in which *P. yuccifoliorum* was found.

The average size of fifty conidia from the eleven fresh collections ranged from 66.7-80.1 x 12.4-14.2, $\bar{\bar{x}}$=72.1 x 13.2 μm. Conidia from the herbarium material averaged 61.4 x 10.2 μm, smaller than any of the averages for the fresh conidia. The ANOVA showed extremely significant variation among the fourteen collections ($Fs=41.59$, $\alpha<.001$). Results of the SS-STP test for the significance of the contributions to the sum of squares among the groups (SSgroups) by sample means of particular interest are shown in Table 1. The critical value for the sum of squares (CVSS) was computed conservatively using df=13, 120. Even so, SS groups (a), (b), (c), and (e) far exceeded the CVSS, so $\alpha<<.001$ for these groups.

Table 1. Sum of Squares Simultaneous Test Procedure Results for ANOVA of the Width of Conidia from Fresh Collections and Herbarium Collections of *Kellermania yuccifoliorum.*

Groups Analyzed	df	SSgroups	MS
(a) all collections	13/636	1515.6262***	2.803
(b) fresh vs herbarium collections	1/648	1206.6935***	
(c) fresh collections only	10/539	275.9527***	
(d) fresh: *Y. brevifolia* vs other sp.	1/548	88.8552**	
(e) fresh: *Y. brevifolia* only	7/392	174.3375***	

***, α=.001; **, α=.01

These results show the significant contributions to the total variation by (1) the fresh vs herbarium source of the conidia [(a) and (b)], (2) the different species on which the fungus was found [(c) and (d)], and (3) the plants or site from which a collection was made--the fresh collections from *Y. brevifolia* were significantly different (e).

Conidia from the herbarium collections averaged 14.8% shorter and 22.7% narrower than those from fresh collections, and the walls appeared fairly thick, rather than thin as in the fresh material. Both these characteristics agree with observations from living versus dead ascomycetes (1), and percent difference in length and width of living versus dead conidia is within the range of the percent difference for such measurements in ascospores. These differences account for the extremely large SSgroups for conidia from fresh versus herbarium material [Table 1, (b)], and emphasize the need for caution when drawing taxonomic conclusions from such measurements, at least for taxa with large, thin-walled conidia.

Planistromella uniseptata Ramaley, *sp. nov.*-----Fig. 2, B.

Planistromellae yuccifoliorum Ramaley similis sed stromata 250-400 μm diam ubi separata, usque ad 350 μm elata, 1-4 locularia. Asci 105-120 x 28-36 μm ante prolationem ultimam et missionem ascosporarum. Ascosporae hyalinae, extrema obtuse rotundata vel extremum inferius plerumque aliquantum acutum, 1-septatae, 32-48 x 13.5-17.5 μm, cellula inferior 1-1.4x longitudo cellulae superioris. Ubi asci vetissimi maturi, textura interthecii irregulariter filamentosa, columnae dissociantes et consortiones 2-3-cellulares vel unicellulares formantes. Cellulae irregulariformes, cylindratae, ellipsoidiae, ovatae, vel globosae, plerumque 10-20 x 5-8 μm.

Like *Planistromella yuccifoliorum* Ramaley, but the stromata 250-400 μm diam when separate, up to 350 μm tall, 1-4 loculate. Asci (Fig. 2, B) 105-120 x 28-36 μm before the final elongation and release of the ascospores. Ascospores (Fig. 2, B) hyaline, the ends bluntly rounded or the lower end more often slightly pointed, 1-septate, 32-48 x 13.5-17.5 μm, the bottom cell 1-1.4x the length of the top cell. When the oldest asci are mature, interthecial tissue irregularly filamentous, the columns dissociating into 2-3-celled associations or into individual cells which are irregularly shaped, cylindric, ellipsoid, ovate, or spherical, mostly 10-20 x 5-8 μm.

Substrate: Leaves of *Yucca elata* Engelmann.

HOLOTYPE: USA. NEW MEXICO: Soccoro County, roadside, west side of Highway 25, mile 105.4, on leaves of *Yucca elata* Engelmann, 12 April 1992, Annette Ramaley No. 9217, UC 1475102.

Planistromella uniseptata was found in small amounts on leaves of *Yucca elata* Engelmann. The anamorph of the fungus is widely distributed in the United States on *Yucca angustifolia* Pursh (6), *Y. filamentosa* Linnaeus (6), *Y. glauca* Nuttall (6), *Y. harrimaniae* Trelease (personal observation), and *Y. whipplei* Torrey (6). When a systematic search is carried out, *P. uniseptata* may be expected on these species as well as *Y. elata*.

Colonies arising from asci on PDA had white aerial, surface, and subsurface mycelium with a pink reverse. After 6 weeks, conidiomata which contained typical *Kellermania yuccigena* conidia had formed.

Anamorph: ***Kellermania yuccigena*** Ellis & Everhart---Fig. 4, D & E.

Kellermania yuccigena has been illustrated and described in modern terms (6, 12). A few additions must be made for a more complete description, but an entire conidioma has not been drawn. In the absence of conidia, the conidiomata could scarcely, if at all, be distinguished from small conidiomata of *K. yuccifoliorum* (Fig. 3, A). Conidiomata are 250-300 (-550) μm diam and up to 450 μm tall. The wall is thick and cup-shaped. As described by Höhnel (4), the top of a conidioma is composed of parallel filaments of elongate golden cells which are very dark-walled in the area surrounding the ostiole. Microconidia are formed on the upper conidiomatal wall and in the ostiolar channel. Conidia are up to 80 μm long, considerably longer than the 50-61μm often cited (6, 13). Part of this difference may be attributed to the irreversible shrinkage of conidia from herbarium specimens (1) which were measured. The amount of filamentous material making up the top of a conidioma is variable. Spermatia are formed in 1-4 separate locules in the filamentous portion of a stroma, or in the central locule with or without accompanying conidia; each locule has an ostiole, or locules coalesce and release spermatia from a single ostiole. Spermatiogenous cells are discrete to integrated on a 1-celled (usually) conidiophore, cylindric to elongate-conical, phialidic, and 5-16 x 2.5-3.2 μm. Spermatia are hyaline, bacillar, and 4-8 x 1.6 μm.

Conidia germinated readily and formed colonies with white aerial, surface, and subsurface mycelium. The reverse was pink. Within 6 weeks, conidiomata had formed which contained typical *Kellermania yuccigena* conidia. *Planistromella uniseptate* and *K. yuccigena* were therefore considered to be two phases of a single holomorph.

DEVELOPMENT

Before the host epidermis is broken, a *Kellermania* conidioma consists of a cup-shaped wall containing maturing macroconidia. The top of a conidioma is made up of columns of elongate golden cells bounded internally by smaller, hyaline cells. As conidiomata mature, the columns of elongate cells lengthen, microconidium formation occurs in and near the ostiolar channel, and the cells that will surround the ostiolar channel become very dark. The microconidiogenous cells look much like periphyses in perithecial ascostromata, but form microconidia as an added feature. The function of microconidia is not known.

A macroconidium develops as a simple outgrowth of a holoblastic conidiogenous cell. In conidiomata potentially developing beyond macroconidium formation, columns of cells are attached well down the lateral walls of the stromata (Fig. 3, compare A, f, & D, d, t) reducing the size of the single, central locule. These conidiomata may form spermatiogenous locules, ascogenous locules, or, very rarely in *Kellermania yuccigena*, additional conidial locules in the columnar filamentous portion. Spermatia are formed in the central locule with or without macroconidia, in small spermatial locules that develop in the lateral upright filaments, or at both sites. Frequently a conidioma forms spermatia in a single,

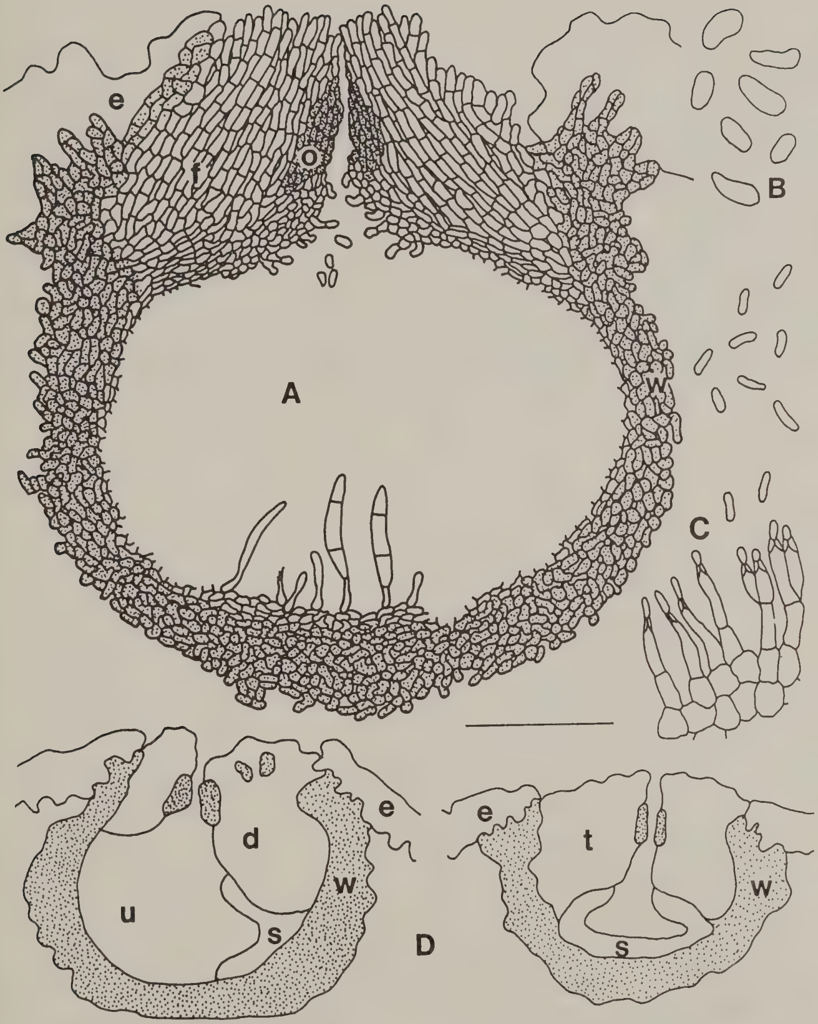

Fig. 3. *Kellermania yuccifoliorum.* A. Small conidioma. B. Microconidia. C. Spermatia and spermatiogenesis. D. Diagrams of stromata. d=columnar filamentous portion of stroma developing into an area of spermatiogenesis, e=host epidermis, f=columnar filamentous portion of stroma, o=dark-walled cells around ostiole or developing ostiole, s=site of spermatiogenesis, t=portion of stroma which may develop ascomata, u=site of conidiogenesis and spermatiogenesis, w=wall. Standard line = A, 80 μm; B, C, 27 μm; D, 200 μm.

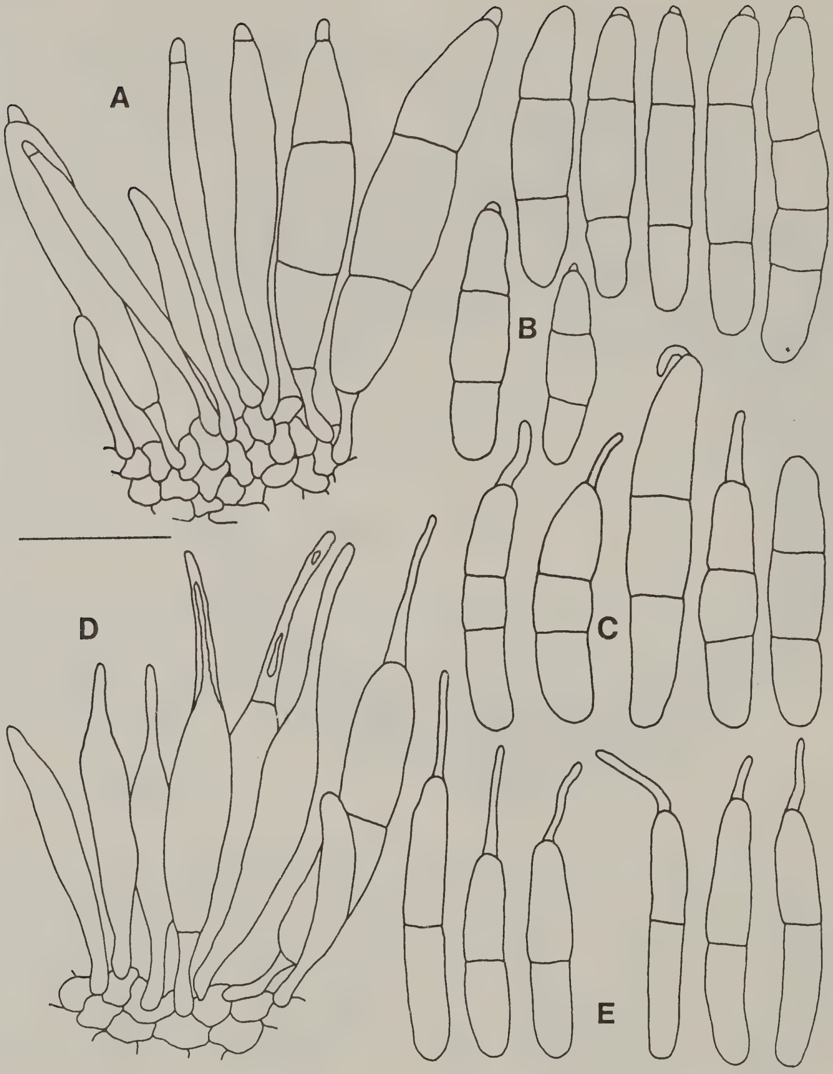

Fig. 4. A, B, *Kellermania yuccifoliorum.* A. Conidiogenesis and origin of apical appendage. B. Conidia. C. *Kellermania anomala* conidia. D, E, *Kellermania yuccigena.* D. Conidiogenesis and origin of apical appendage. E. Conidia. Standard line = A, D, 27 μm; B, C, E, 40 μm.

central locule, and then develops 1-4 sites in the columnar filamentous portion where the cells become hyaline and subdivided. Spermatia adhere to the several flexuous hyphae produced at each site.

Planistromella develops in pre-formed stromata which have already produced conidia, spermatia, or both. Walls of the central locule are collapsed by expansion of the ascogenous locules. The asci mature among cells of the copious centrum tissues. These elongate cells, arranged in columns, may be laterally compressed between maturing asci, but not much stretched. Dissolution of the sterile cells begins at the upper end of the locule and proceeds downward. They are still abundant as early-formed asci mature. In *P. yuccifoliorum* the interthecial tissues are clearly filamentous as early-formed asci mature. In *P. uniseptata* the interthecial tissues are irregularly filamentous, dissociating into single cells or 2-3-celled series as the asci mature. In *P. uniseptata* the asci elongate greatly, extending beyond the periphysate ostile for ascospore release. Probably living mature *P. yuccifoliorum* asci elongate similarly, but this could not be ascertained in the herbarium material which was mostly immature.

DISCUSSION

Beyond its similarity to *Planistroma*, *Planistromella* relationships are not clear. (a) *Planistroma* asci are like those of the Botryosphaeriaceae (P. F. Cannon, personal communication), as are the non-septate ascospores of *Planistroma*. However, the type, *Botryosphaeria dothidea* (Mougeot ex Fries) Cesati & De Notaris, has the *Pleospora* type of centrum development (7) which is not found in *Planistromella* or *Planistroma*. (b) Several ascomycetes have 2-septate ascospores. It is improbable that the two ascospore septa are formed simultaneously in *Kiessleriella ocellata* (Niessl) Bose or *Paraphaeosphaeria michotii* (Westendorp) O. Eriksson which have brown ascospores, or *Buergenerula* Sydow with hyaline ascospores, because of their relationships. *Leptoguignardia* Müller has hyaline ascospores with two simultaneously-formed septa. None of these fungi has a multilocular stroma, and the ascostromata are separate from the conidiostromata so far as is known, though the two are found in the same material for *Leptoguignardia.* (c) *Planistromella* is also distinct from the known teleomorphs for *Stagonospora* (11) which belong to *Leptosphaeria* (7 species), *Pleospora* (2 species), and *Didymella* (1 species). These fungi have unilocular pseudothecia, pseudoparaphyses that originate above the asci and grow downward to the base of the locule, and, except for *Didymella*, colored ascospores that are several septate or dictyosporous. According to existing descriptions, ascospore septation is sequential, not simultaneous.

The *Planistromella* anamorph, *Kellermania yuccifoliorum*, would once have been forced into *Stagonospora gigantea.* However, the two taxa can be separated easily. Conidia of *K. yuccifoliorum* are nearly always 2-septate, and commonly have a short apical appendage; *Stagonospora gigantea* conidia are (3-)4-5(-7) septate, and lack an apical appendage. *K. yuccifoliorum* forms microconidia near the ostiole and in the ostiolar channel; *S. gigantea* has periphysis-like cells present in these areas, but does not form microconidia. The wall of *Kellermania* is gray-black when young, sometimes becoming dark brown in age, whereas the wall of *S. gigantea* is brown.

The new anamorph taxon was clearly related to *Kellermania* and *Piptarthron* by details of the life cycle and structure of the conidiomata. These genera are distinguished by the presence of a single apical appendage on *Kellermania* conidia. Conidial appendages vary in origin. To place the anamorph properly, it was necessary to determine whether the small conidial appendages of the taxon newly separated from *S. gigantea* resembled the larger conidial appendages of existing *Kellermania* species.

Kellermania yuccifoliorum conidia originate as simple outgrowths of the holoblastic conidiogenous cells (Fig. 4, A). The cells elongate, often with little increase in width, and in many of them the apex of the conidium becomes filled with material that cannot be distinguished from the cell wall in unstained, living cells. The conidia then increase in width, become septate, and enlarge somewhat until they are mature. The occluded apex is the 'apical appendage' which retains the shape of the conidial initial at the time of appendage formation. The apical cell may be truncate even when conidia are mature, and the appendage becomes distinguishable from the cell wall. Origin of the apical appendage is 'cellular' in the sense that it is not material extruded from a cell, but it differs from the 'cellular' appendages of *Heteropatella, Scolecosporiella,* and *Chaetoconis* which are apical cells drawn out into a filiform appendage.

Conidiogenesis was also examined in fresh collections of *K. yuccigena* (Fig. 4, D) with newly-formed conidiomata. In unstained, untreated preparations, developing conidia elongated to a sharp point bounded by a normal-appearing cell wall. The lumen of the apex filled, and the cytoplasmic contents in the narrowed apex were replaced. The wall of the pointed apex was separable from the surrounding conidial sheath, but could not be distinguished from the contents replacing the cytoplasm in the attentuated apex. No septum was ever seen between the apex and the remainder of the conidium, nor did the cytoplasmic contents retract from the apex as in *Monochaetiellopsis* (8). During the filling of the apex, small stainable areas persisted for some time. The appendages originated as cellular projections, as do those of conidia of *Monochaetiella hyparrheniae* Castell (8), but the protoplasmic contents were then replaced. The origin of *K. yuccigena* appendages seemed identical to, though more elaborate than, the origin of *K. yuccifoliorum* appendages.

The above results are contrary to those of an earlier report (12) which describes *Kellermania yuccigena* appendages as unstainable material in the apical region of the most immature subulate conidia which becomes increasingly elongated as the conidium matures. The fresh collections were put aside for later study to try to reconcile the differences. When the collections were re-examined several months later, not one sharply pointed conidium could be found with an open narrowed apex. All apices were filled, making it appear that the appendage originated outside the cell wall and increased in size as the conidium developed. The reaction of the fungus to storage had obscured the true origin of the conidial apical appendage. Since the conidial appendages of the new taxon originated like those of *K. yuccigena*, it was designated a species of *Kellermania*, and not considered to be a new, related genus.

The close relationship of *Kellermania* and *Piptarthron* was recognized by Höhnel when he validated the genus *Piptarthron* (5). The teleomorphs for the two genera are also much alike, but differ consistently in the species studied to this point. Typical aseptate *Planistroma* ascospores, differing in size, have been found in three of the four *Piptarthron* species whose teleomorphs have been observed (9 and unpublished). *Planistroma obtusilunatum* Ramaley has ascospores that are shaped differently from the other *Planistroma* species (10), but they are aseptate. The *Planistromella* teleomorphs for *K. yuccigena,* and *K. yuccifoliorum* differ from *Planistroma* by their possessing septate ascospores. The same is true for the teleomorph of *K. anomala.* The single observed ascus of that species contained medianly 1-septate ascospores. A simplification would be to include both anamorph genera in the earlier genus, *Kellermania*, and both teleomorph genera in *Planistroma.* However, the generic limits are remarkably consistent as they stand.

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Literature Cited

1. Baral, H. O. 1992. Vital versus Herbarium Taxonomy: Morphological Differences Between Living and Dead Cells of Ascomycetes, and Their Taxonomic Implications. Mycotaxon 44: 333-390.
2. Farr, D. F., Bills, G. F., Chamuris, G. P., and Rossman, A. Y. 1989. Fungi on Plants and Plant Products in the United States. The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, Minnesota 55121, U.S.A.
3. Heald, F. D., and Wolf, F. A. 1911. New Species of Texas Fungi. Mycologia 3: 522.
4. Höhnel, F. v. 1915. Fragmente zur Mykologie no. 900. Über die Gattung *Kellermania* Ellis and Everhart. Sitzungsber. Kais. Akad. Wiss. Wien, Math-Naturwiss. cl. Abt. 1, 124: 82-84.

5. Höhnel, F. v. 1918. Fungi imperfecti. Beiträge zur Kenntnis derselben. Hedwigia 60: 129-209.
6. Morgan-Jones, G., Nag Raj, T. R., and Kendrick, B. 1972. Genera Coelomycetarum. VI. *Kellermania.* Can. J. Bot. 50: 1641-1648.
7. Parguey-Leduc, A. 1966. Recherches sur L'Ontogénie et L'Anatomie Comparée des Ascocarpes des Pyrénomycètes Ascoloculaires. Ann. Sci. Naturelles, Bot., 12 ser. 7: 505-690.
8. Punithalingam, E. 1992. The Nuclei and Conidial Appendages in *Monochaetiellopsis* species (Coelomycetes). Nova Hedwigia 54: 255-267.
9. Ramaley, A. W. 1991. Fungi of *Yucca baccata.* 1. *Piptarthron pluriloculare* and Its Teleomorph, *Planistroma yuccigena.* Mycotaxon 42: 63-75.
10. Ramaley, A. W. 1992. Fungi From *Yucca baccata* 2. *Planistroma obtusilunatum sp. nov.,* and Its Anamorph, *Piptarthron uniloculare sp. nov.* Mycotaxon 45: 449-460.
11. Sivanesan, A. 1984. The Bitunicate Ascomycetes and Their Anamorphs. A. R. Gantner Verglag K. G., F19490 Vaduz.
12. Sutton, B. C. 1968. *Kellermania* and Its Generic Segregates. Can. J. Bot. 46: 181-196.
13. Sutton, B. C. 1980. The Coelomycetes. Commonwealth Mycol. Inst., Kew, Surrey, England.

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4-O-METHYLLIVIDIC ACID, A NEW LICHEN DEPSIDONE

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ABSTRACT : The depsidone, 4-*O*-methyllividic acid (8-hydroxy-3,4-dimethoxy-1-(2'-oxoheptyl)-6-pentyl-11-oxo-11*H*-dibenzo[*b,e*][1,4]dioxepin-7-carboxylic acid (11) has been identified in the lichens *Hypocenomyce foveata, Hypotrachyna immaculata, H. livida* and *H. osseoalba* and was synthesized and characterized.

Introduction

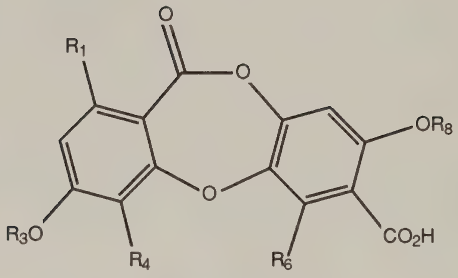
Minor biosynthetic variations observed within a lichen genus or a group of related species can produce a large number of structurally related metabolites or a chemosyndrome (Culberson & Culberson 1976). The structural variations within a chemosyndrome take several forms and in the orcinol depsidones (1) these include :

i. variations in the length of the polyketide derived side chain R^1.
ii. the degree of oxidation of this side chain (i.e. CH_2COR' or CH_2CH_2R').
iii. the degree of methylation of the phenolic groups (i.e. R^3, R^8 = Me or H).
iv. the presence/absence of an additional phenolic hydroxy group (or derived methoxy group) in position 4.

Lichens of the genus *Hypotrachyna*, more particularly *H. osseoalba* (Vain.) Park & Hale, *H. livida* (Taylor) Hale and *H. immaculata* (Kurok.) Hale produce such a chemosyndrome, the following members of which have been identified previously; norcolensoic acid (2), colensoic acid (3), hydroxycolensoic acid (4), methoxycolensoic acid (5), physodic acid (6), 3-*O*-methylphysodic acid (7) [unfortunately this compound was originally termed 4-*O*-methylphysodic acid, using a now-obsolete numbering system] oxyphysodic acid (8) and lividic acid (9) (Chester & Elix 1981; Culberson 1966; Djura, Sargent et al. 1977a, 1977b; Elix & Engkaninan 1976; Elix & Johnston 1991).

Materials and Methods

The lichen fragments were freed as far as possible from obvious organic substrate material and extracted with warm acetone for thin-layer chromatography (TLC) or with warm methanol for high performance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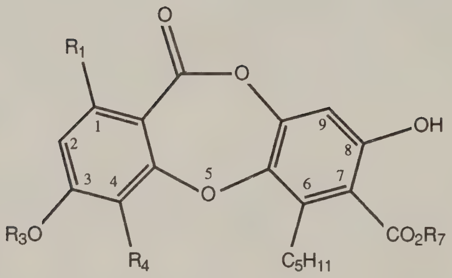
R$_1$
O
OR$_8$
O
R$_3$O
R$_4$
R$_6$
CO$_2$H

1


O
R$_1$
O
OH
1
2
3
4
5
6
7
8
9
O
R$_3$O
R$_4$
C$_5$H$_{11}$
CO$_2$R$_7$

	R$_1$	R$_3$	R$_4$	R$_6$	R$_7$
2	C_5H_{11}	H	H	C_5H_{11}	H
3	C_5H_{11}	Me	H	C_5H_{11}	H
4	C_5H_{11}	Me	OH	C_5H_{11}	H
5	C_5H_{11}	Me	OMe	C_5H_{11}	H
6	$CH_2COC_5H_{11}$	H	H	C_5H_{11}	H
7	$CH_2COC_5H_{11}$	Me	H	C_5H_{11}	H
8	$CH_2COC_5H_{11}$	H	OH	C_5H_{11}	H
9	$CH_2COC_5H_{11}$	Me	OH	C_5H_{11}	H
10	$CH_2COC_5H_{11}$	Me	OMe	C_5H_{11}	H
11	$CH_2COC_5H_{11}$	H	OMe	C_5H_{11}	$CH_2C_6H_5$
12	$CH_2COC_5H_{11}$	Me	OMe	C_5H_{11}	$CH_2C_6H_5$

liquid chromatography (HPLC). Compounds were identified by TLC using the methods standardized for lichen products (Culberson & Ammann, 1979; Culberson & Johnson 1976, 1982; Elix, Johnston & Parker, 1987) and by HPLC with retention index values (RI) calculated from benzoic acid and solorinic acid controls (Feige, Lumbsch, Huneck & Elix, 1993). HPLC used a Spectra System, a Perkin-Elmer HS-5C18 column and a spectrometric detector operating at 254 nm with a flow rate of 1 ml/min. Two solvent systems were used: 1% aqueous orthophosphoric acid and methanol in ratio 3:7 (A) and methanol (B). The run started with 100% A and was raised to 58% B within 15 min., then to 100% B in 30 min. and isocratic elution in 100% B for a further 10 min.

The following lichens were studied:

Hypocemomyce foveata **Timdal**

AUSTRALIA. Australian Capital Territory. On trunk of *Eucalyptus macrorhyncha* in dry *Eucalyptus* woodland, Canberra Nature Park, Bruce Ridge, 35°15'S, 149°05'E, *J. A. Elix 27485*, 26.i.1991 (ANUC). New South Wales. At base of trunk of *Eucalyptus macrorhyncha* in dry *Eucalyptus* woodland, Great Dividing Range, Tuena-Binda road, 30 km north-west of Crookwell, 34°13'S, 149°20'E, *J. A. Elix 27483* , 12.ix.1990 (ANUC).

Hypotrachyna immaculata **(Kurok.) Hale**

AUSTRALIA. Australian Capital Territory. On *Leptospermum* shrubs in *Eucalyptus* woodland, trail to Booroomba Rocks, 11 km south-west of Tharwa, 35°35'S, 149°02'E, *J. A. Elix 4027*, 16.ii.1977 (ANUC). REPUBLIC of SOUTH AFRICA. Cape Province. On old oaks, Stormsrivier, Distr. Humansdorp, *O. Almborn 4133*, 28.viii.1953 (ANUC).

Hypotrachyna osseoalba **(Vain.) Hale & Park**

AUSTRALIA. Queensland. On *Alphitonia* in disturbed rainforest, Lannercost State Forest, Old Mill Road, 36 km WSW of Ingham, 18°45'S, 145°49'E, *J. A. Elix 15609*, 19.vi.1984 (ANUC). NEW ZEALAND. South Island. On kahikatea in swampy forest, Little Ditch, 8 km north-east of Waimangaroa, *J. A. Elix 7273*, 26.ii.1980 (ANUC).

The following authentic compounds have been synthesised or isolated previously: norcolensoic acid (2) (Chester & Elix, 1981); colensoic acid (3) (Djura & Sargent 1976); hydroxycolensoic acid (4) and methoxycolensoic acid (5) (Djura, Sargent et al. 1977a,b); physodic acid (6), 3-*O*-methylphysodic acid (7) and oxyphysodic acid (8) (Elix 1975) and lividic acid (9) (Elix & Engkaninan 1976).

Synthesis of 4-*O*-Methyllividic acid (10)

Benzyl 4-O-Methyllividate (11)

Benzyl 4-methoxyphysodate (12) (Elix & Engkaninan 1976) (17.5 mg, 29.6 µmole) was treated with an excess of ethereal diazomethane for a period of 6 hours. The ethereal solution was treated with glacial acetic acid (2 drops) and washed in turn with saturated sodium bicarbonate solution, brine, and dried ($MgSO_4$). The residue obtained on evaporation of the solvent was crystallized from light petroleum to yield *benzyl 4-O-methyllividate* (11) (11.6 mg, 65%), as colourless needles m.p. 109.5-111° (Found: mol. wt. 604.2670. $^{12}C_{35}{}^{1}H_{40}{}^{16}O_9$, require mol. wt. 604.2672). ^1H n.m.r. ($CDCl_3$) δ 0.78-0.91, m, $CH_2\mathbf{CH_3}$; 1.21-1.62, m, $CH_2\mathbf{(CH_2)}_3CH_3$; 2.55, t, $CO\mathbf{CH_2}CH_2$; 3.26, t, $Ar\mathbf{CH_2}CH_2$; 3.76, s, 2H, $ArCH_2CO$; 3.89, s, OCH_3; 5.37, s, CO_2CH_2; 6.56, 6.75, 2s, H2, H9; 7.41, m, C_6H_5; 11.19, s, OH. Mass spectrum *m/z* 605 (10%), 604 (M, 29), 513 (3), 469 (6).

4-O-Methyllividic Acid (10)

A solution of benzyl 4-*O*-methyllividate (11) (11.6 mg, 19. µmole) in ethyl acetate, containing 10% palladium-on-carbon (3.9 mg) was stirred in an atmosphere of hydrogen at room temperature for 1.5 hours. The reaction mixture was filtered to remove the catalyst and the catalyst washed with ethyl acetate. The combined filtrate was then evaporated under reduced pressure and the residue crystallized from dichloromethane/light petroleum, to afford 4-O-*methyllividic acid* (10) (5.0 mg, 51%) as colourless needles, m.p. 156.5-159° (Found: mol. wt. 470.2305. $^{12}C_{27}{}^{1}H_{34}{}^{16}O_7$, requires mol. wt. 470.2305). ^1H n.m.r. ($CDCl_3$) δ 0.88-0.94, m, $CH_2\mathbf{CH_3}$; 1.24-1.65, m, $CH_2\mathbf{(CH_2)}_3CH_3$; 2.57, t, $CO\mathbf{CH_2}CH_2$; 3.40, bt, $Ar\mathbf{CH_2}CH_2$; 3.92, s, $ArCH_2CO$; 3.91, 3.96, 2s, OCH_3; 6.58, 6.76, 2s, H2, H9; 11.2-11.4, b, OH. Mass spectrum *m/z* 471 (32%), 470 (M, 100), 293 (16), 292 (42), 277 (38), 263 (16), 221 (12), 207 (14).

Results and Discussion

The lichen *Hypotrachyna immaculata* was shown by HPLC and TLC to produce nine phenolic metabolites, eight of which corresponded to known lichen substances. These included the common cortical depsides atranorin and chloroatranorin, and the orcinol depsidones norcolensoic acid (2), colensoic acid (3), physodic acid (6), 3-*O*-methylphysodic acid (7), oxyphysodic acid (8) and lividic acid (9), all of which were readily identified by comparison with authentic materials (Figure 1).

Subsequently we have undertaken the synthesis of 4-*O*-methyllividic acid (10), and found that the TLC and HPLC behaviour of this compound to be identical with that of the eighth phenolic substance present in *H. immaculata*. This new depsidone has also been detected in several other lichens which contain the colensoic acid - lividic acid chemosyndrome

chemosyndrome including *Hypocenomyce foveata* Timdal and *Hypotrachyna osseoalba* (Vain.) Park & Hale.

4-*O*-Methyllividic acid (10) was prepared by hydrogenolysis of benzyl 4-*O*-methyllividate (11), which in turn was obtained by methylation of benzyl 4-methoxyphysodate (12) (Elix & Engakinan 1976). The standardized chromatographic data for these compounds are listed in Table 1.

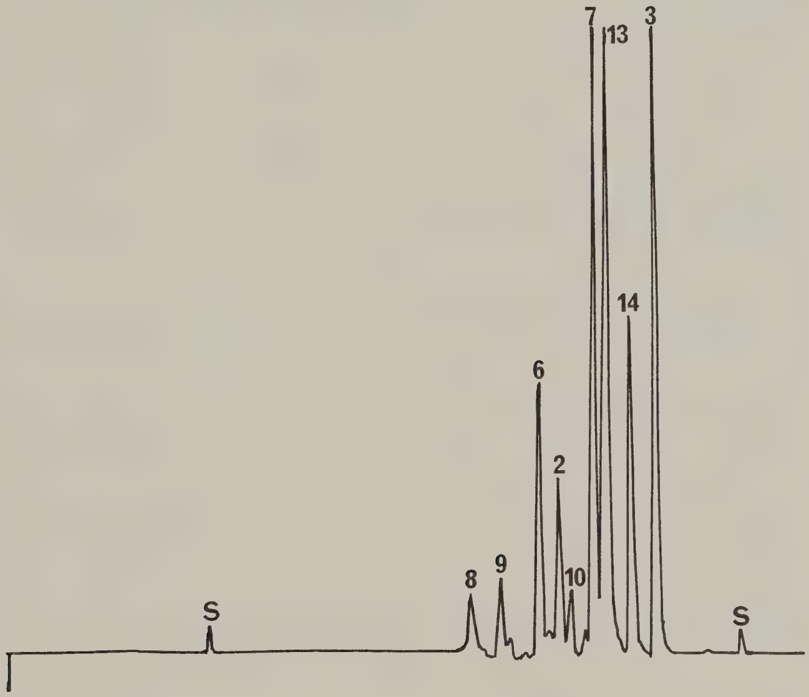


Figure 1. H.p.l.c. trace of *Hypotrachyna immaculata* (*J. A. Elix 4027* in ANUC). S = internal standard.

ACKNOWLEDGEMENTS

We thank the Australian Research Council for generous financial support of this project; Mr. G. Deeble (HPLC), Ms. Caroline Barclay (HPLC) and Ms. S. A. Elix (TLC) who assisted in the determination of the chemistry of many specimens. A Commonwealth Postgraduate Award to (D.V.) is gratefully acknowledged.

Table 1: **Standardized Chromatographic Data for *Hypotrachyna* Metabolites**

Standard R_F values (x 100) were determined in three independent t.l.c. solvent systems: (A) toluene / dioxane / acetic acid (180 : 45 : 5); ((B*) hexane / *t*-butyl methyl ether / formic acid (140 : 72 : 18); (C) toluene / acetic acid (170 : 30). HPLC retention index (RI) values (x 100) are relative to solorinic acid and benzoic acid.

Compound R_F	(A)	(B*)	(C)	*RI*
Norcolensoic Acid (2)	28	53	31	67.0
Colensoic Acid (3)	41	66	47	85.0
Hydroxycolensoic Acid (4)	39	50	42	63.6
Methoxycolensoic Acid (5)	44	61	47	77.0
Physodic Acid (6)	25	35	18	63.3
3-*O*-Methylphysodic Acid (7)	39	45	42	73.3
Oxyphysodic Acid (8)	15	34	13	51.1
Lividic Acid (9)	32	37	31	56.8
4-O-Methyllividic Acid (10)	41	46	39	68.6
Atranorin (13) (Standard)	75	73	79	76.3
Chloroatranorin (14) (Standard)	74	73	81	80.6

LITERATURE CITED

Chester, D. O. & Elix, J. A. (1981). New metabolites from Australian lichens. *Aust. J. Chem.* **34**: 1507-1511.

Culberson, C. F. (1966). The structure of a new depsidone from the lichen *Parmelia livida*. *Phytochemistry* **5**: 815-818.

Culberson, C. F. (1972). Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromatogr.* **72**: 113-125.

Culberson, C. F. & Ammann, K. (1979). Standardmethode zur Dünnschichtchromatographie von Flechtensubstanzen. *Herzogia* **5** : 1-24.

Culberson, C. F. & Culberson, W. L. (1976). Chemosyndromic variation in lichens. *Syst. Bot.* **1**: 325-339.

Culberson, C. F. & Johnson, A. (1982). Substitution of methyl *tert.*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *J. Chromatogr.* **238**: 483-487.

Djura, P. & Sargent, M. V. (1976). Depsidone Synthesis. VI. Colensoic acid. *Aust. J. Chem.* **29**: 1069-1077.

Djura, P., Sargent, M. V., Elix, J. A., Engkaninan, U., Huneck, S., & Culberson, C. F. (1977a). Depsidone synthesis. VII. Isolation and structure determination of hydroxy- and methoxy-colensoic acids. Synthesis of methyl methoxy-*O*-methylcolensoate. *Aust. J. Chem.* **30**: 599-607.

Djura, P., Sargent, M. V., & Clark, P. D. (1977b). Depsidone synthesis. X. Methoxy- and hydroxy-colensoic acids. *Aust. J. Chem.* **30**: 1545-1551.

Elix, J. A. (1975). 2'-*O*-Methylphysodic acid and hydroxyphysodic acid: two new depsidones from the lichen *Hypogymnia billardieri*. *Aust. J. Chem.* **28**: 849-858.

Elix, J. A. & Engkaninan, U. (1976). The structure of lividic acid, a depsidone from the lichen *Parmelia formosana*. *Aust. J. Chem.* **29**: 203-207.

Elix, J. A. and Johnston, J. (1991). Additional lichen records for New Zealand. 3. Further representatives in the family Parmeliaceae. *Australasian Lichenological Newsletter* **28**: 7-10.

Elix, J. A., Johnston, J. & Parker, J. L. (1987). A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances (Aust. Nat. University, Canberra).

Elix, J. A., Johnston, J. & Parker, J. L. (1988). A Computer Program for the Rapid Identification of Lichen Substances. *Mycotaxon* **31**: 89-99.

Feige, G. B., Lumbsch, H. T., Huneck, S. & Elix, J. A. (1993). The identification of lichen substances by a standardized high-performance liquid chromatographic method. *J. Chromatogr.* in press.

MYCOTAXON

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ANAEROMYCES, AN EARLIER NAME FOR RUMINOMYCES

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ABSTRACT

Ruminomyces Ho is placed into synonymy with *Anaeromyces* Breton and comparison is made between *A. mucronatus* and *A. elegans* (Ho) Ho comb. nov.

There were two taxa of anaerobic polycentric fungi described in 1990 from the rumen of cattle (*Bos taurus*). One was from France and the other from Australia. The one from France was named *Anaeromyces mucronatus* Breton while the other from Australia was called *Ruminomyces elegans* Ho. In our opinion the two generic diagnoses are essentially similar and the two genera are synonymous. Thus, there is no justification for retaining them as two separate genera. The generic name *Anaeromyces* has priority as it was published July 19, 1990 whereas *Ruminomyces* was published August 15, 1990. However, the species are morphologically distinct and should be retained as separate taxa. The following combination is therefore proposed:

Anaeromyces elegans (Ho) Ho comb. nov.
= *Ruminomyces elegans* Ho (Ho *et al.* 1990).
Mycotaxon 38 : 398 - 404.

Although the morphology and size of the sporangia and zoospores of *A. elegans* and *A. mucronatus* are somewhat similar, the rhizomycelia of the two species are clearly different.

The rhizomycelium of *A. elegans* is composed of much-branched, narrow to wide hyphae ranging from 0.5 - 10 μm wide. Many of the wide hyphae are sausage-shaped with constrictions at regular or irregular intervals. Some hyphae also produce lobed or bead-like structures, 1.5 - 14.5 μm wide x 1.5 - 12.5 μm high. Frequently, fine pegs (about 0.5 μm wide) are produced from the centre of these lobed or bead-liked structures. The characteristics of these structures appear to be similar to the penetrating structures "appressoria" produced by anaerobic fungi colonising grass and straw fragments in the rumen of cattle and swamp buffalo (Ho *et al.*, 1988a, b; 1991). The hyphae of *A. mucronatus*, though with constrictions, do not possess the lobed or bead-like structures. Although the difference may eventually prove to be inconsequential, in our opinion, it is preferable to retain the two species until the cultures are compared under similar growing conditions and analysed by molecular analysis.

REFERENCES

Breton, A., Bernalier, A., Dusser, M., Fonty, G., Gaillard-Martinie, B. & Guillot, J. (1990). *Anaeromyces mucronatus* nov. gen., nov. sp. A new strictly anaerobic rumen fungus with polycentric thallus. *FEMS Microbiology Letters 70*, 177 - 182.

Ho, Y.W., Abdullah, N. & Jalaludin, S. (1988a) Penetrating structures of anaerobic rumen fungi in cattle and swamp buffalo. *Journal of General Microbiology 134*, 177 - 181.

Ho, Y. W., Abdullah, N. & Jalaludin, S. (1988b), Colonization of guinea grass by anaerobic rumen fungi in swamp buffalo and cattle. *Animal Feed Science and Technology 22*, 161 - 171.

Ho, Y. W., Bauchop, T., Abdullah, N. & Jalaludin, S. (1990). *Ruminomyces elegans* gen. et sp. nov., a polycentric anaerobic rumen fungus from cattle. *Mycotaxon 38*, 397 - 405.

Ho, Y. W., Abdullah, N. & Jalaludin, S. (1991). Fungal colonization of rice straw and palm press fibre in the rumen of cattle and buffalo. *Animal Feed Science and Technology 34*, 311 - 321.

MYCOTAXON

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A NEW SPECIES OF PIROMYCES FROM THE RUMEN OF DEER IN MALAYSIA

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ABSTRACT

Piromyces minutus, a new species of anaerobic fungus from the rumen of deer is described and illustrated. The fungus is characterised by small sporangia, each with a wide apical discharge pore, persistent sporangial wall and straight, unbranched main rhizoid terminating in a sparsely-branched rhizoidal system.

The name *Piromonas communis* Liebetanz was established in 1910 for a uniflagellated rumen organism presumed at that time to be a flagellated protozoan. Later, Orpin (1977) discovered a rumen fungal isolate with a vegetative phase which he associated with Liebetanz's *Piromonas communis*, but his isolate was clearly a Chytridiomycete. Because it is not possible to know the true nature of the organism Liebetanz observed, Gold *et al.* (1988) established a new generic name, *Piromyces*, for Orpin's fungus and the description was later emended by Li *et al.* (1990). The name *Piromonas* could perhaps have been validated and retained as it had been used in the literature up to 1988. However, *Piromyces* is now generally accepted.

There are two other species of *Piromonas* that need mention. These are *Piromonas minima* Liebetanz and *Piromonas maxima* Liebetanz, but we regard these as ambiguous names. The descriptions were based entirely on zoospore size and morphology (Liebetanz, 1910), and although it is possible that these were chytrids, it is not possible to verify or relate them to any known rumen fungal species.

At present, four species have been formally described and included in the genus *Piromyces*. They are *P. communis* Gold (Gold *et al.*, 1988, = *Piromonas communis* Sensu Orpin, 1977), *P. mae* Li (Li *et al.*, 1990), *P. dumbonica* Li (Li *et al.*, 1990) and *P. rhizinflata* Breton (Breton *et al.*, 1991).

Recently, two morphological forms of *Piromyces* were isolated over a two-month period from the rumen contents of Sika or Japanese deer (*Cervus nippon*) fed guinea grass (*Panicum maximum*) in Malaysia. One of the morphological forms was similar to *P. communis* but the other had conspicuously smaller sporangia with persistent wall following release of zoospores through a wide apical pore and is thought to be a new species as it is distinctly different from the four *Piromyces* species described.

The method for isolating the fungi from the rumen contents was similar to that described by Ho & Bauchop (1991) except that glucose agar instead of cellulose agar was used in the roll tubes. The media for maintaining and culturing the isolates were glucose sloppy agar, cellulose sloppy agar and liquid medium with Whatman No. 1 filter paper or rice straw as carbon source (Ho & Bauchop, 1991).

Piromyces minutus Ho sp. nov. Figs. 1-14

Thallus monocentricus eucarpicus. Sporangium omnino endogenum, plerumque parvum denique ellipsoidale vel pyriforme vel globosum, 8-25 μm latum, 8.5-28 μm longum, unico poro apicali emittenti lato et pariete sporangii persistenti, sed interdum grandius denique globosum vel parum irregulare, 40-80 μm diametro, 1-2 (uno vel duobus) poris emittentibus. Axis rhizoidei singularis, aliquando 2-4 (duo vel quatuor). Rhizoideum principale sporangiorum parvorum nonramosum, systeme rhizoidali parce ramoso terminans. Zoosporae globosae 5.7-7.5 μm diametro, uno interdum duobus raro quatuor flagellis usque ad 31 μm longis. Sporangia perdurantia ignota. Species obligate anaerobia.

Thallus monocentric and eucarpic consisting of a sporangium and filamentous rhizoidal system. Sporangia strictly endogenous, predominantly small, ellipsoidal, pyriform or globose, 8 - 25 μm wide x 8.5 - 28 μm long with one wide, apical discharge pore and persistent sporangial wall but occasionally larger, globose or slightly irregular, 40 - 80 μm diameter with one or two discharge pores. Rhizoidal axis single, occasionally two to four. Main rhizoid of small sporangia usually unbranched, terminating in a sparely-branched rhizoidal system. Zoospores globose, 5.5 - 7.5 μm in diameter with one flagellum, occasionally two, rarely four, up to 31 μm long. Resting spores unknown. Obligate anaerobe.

From rumen contents of Sika or Japanese deer (*Cervus nippon*), Universiti Pertanian Malaysia, Serdang, Malaysia, 12 May, 1992, Y.W. Ho and D.J.S. Barr, D2 (UPM) holotypus.

The zoospores of *P. minutus* are globose (Fig. 1), 5.5 - 7.5 μm in diameter when actively moving or stationary but occasionally irregular and amoeboid just before encystment. They are usually monoflagellated, occasionally biflagellated and rarely quadriflagellated. The flagellum is up to 31 μm long including a short whiplash. Shed flagella frequently possess a bead-like structure (0.5 - 1.5 μm in diameter) at one end. Similar flagellar structure has been reported by Barr *et al.* (1989) and Ho *et al.* (1993).

Germination of zoospores produces strictly endogenous thallus development in all the four types of culture media used and in cultures of different ages, including old cultures 4-5 days old. The encysted zoospore expands uniformly and produces a germ tube (Fig. 2) which develops into a main rhizoid. Two types of rhizoidal systems are formed. In one type the main rhizoid is often straight and unbranched for some length (up to 225 μm) before branching to form a sparse rhizoidal system (Fig. 3). It is narrow, 1.5 - 4.5 μm in diameter, usually quite even over its length but occasionally with swellings and tightly constricted points (Figs. 4). The ends of the rhizoids are straight with moderately blunt tips. Usually a single main rhizoid is produced but occasionally two or more are formed (Figs. 5-6). This type of rhizoidal system is predominantly formed in all the four culture media used. In the other type of rhizoidal system, the main rhizoid is much wider, 5.5 - 11.5 μm in diameter, sometimes coiled and more densely branched (Figs. 7 - 9). The ends of the rhizoids are usually straight

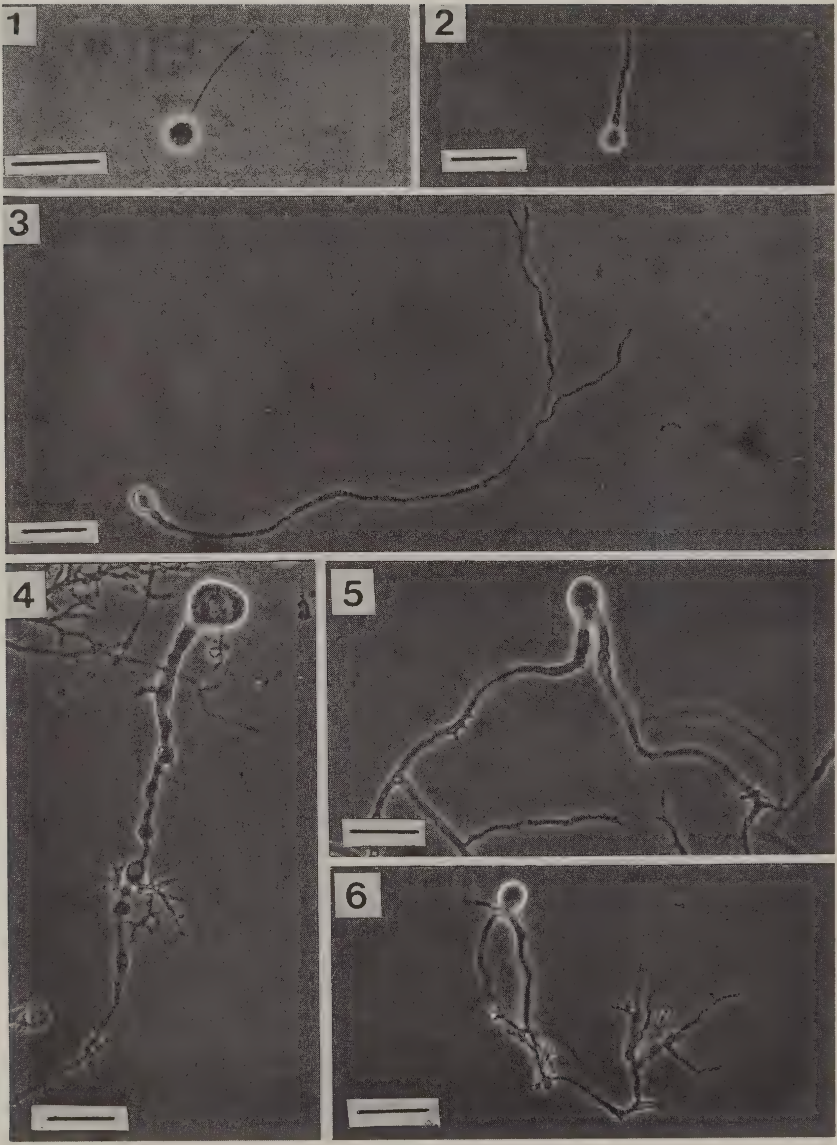


Fig. 1. Zoospore of *P.minutus.* Fig. 2. A germinating zoospore. Fig. 3. Rhizoidal system showing straight and unbranched main rhizoid terminating in sparsely-branched rhizoids. Diameter of the main rhizoid is even without constrictions. Fig. 4. Main rhizoid with swellings and constrictions. Figs. 5-6. Rhizoidal system with two and three main rhizoids respectively. Bar = 20μm.

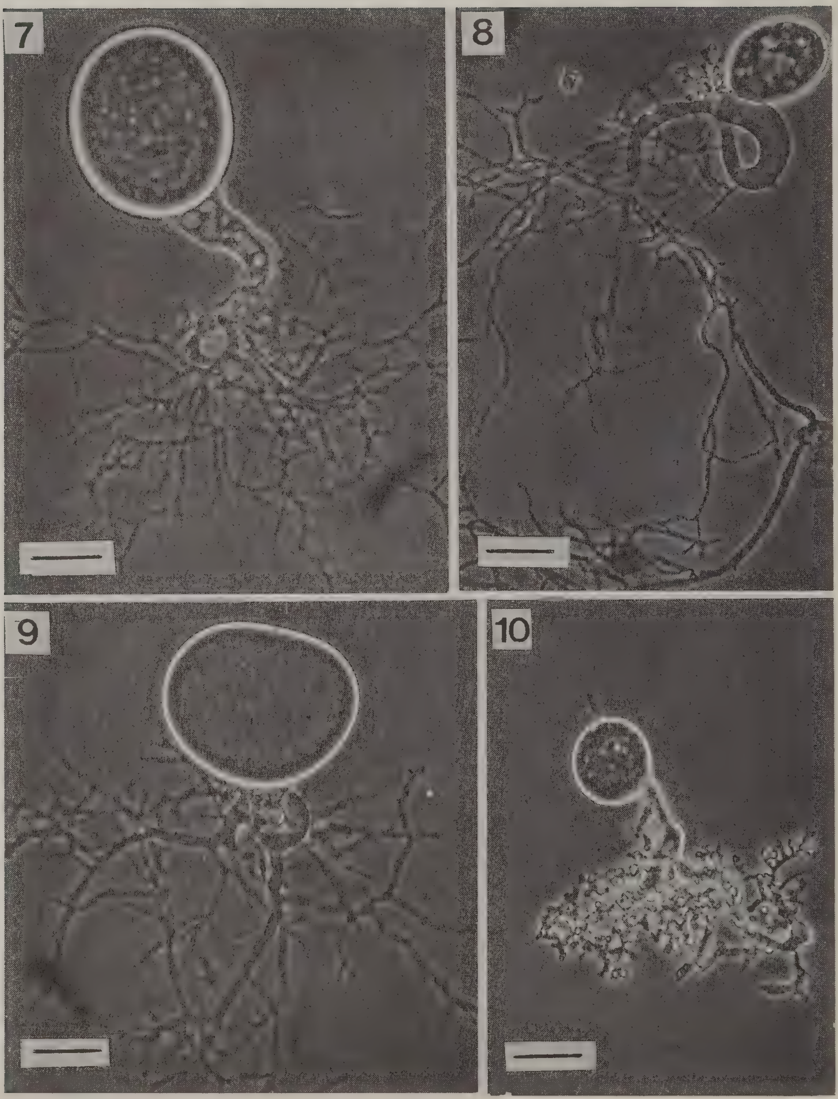
and moderately blunt but occasionally they are rounded and slightly expanded resembling small pegs (Fig. 10).

At maturity, the rhizoidal system is separated from the sporangium by a septum at the neck (the point between the sporangium and main rhizoid) or at the base of the sporangium.

The sporangium develops from the expansion of the encysted zoospore. Sporangium shape is variable. Small sporangia are predominantly formed. They are mostly ellipsoidal to pyriform, 8 - 25 μm wide x 8.5 - 28 μm long, occasionally globose. They possess the rhizoidal system with long, straight main rhizoid terminating with sparse branches. Zoospores are discharged following dissolution of a wide apical portion of the sporangial wall (Fig. 11). After discharge, a persistent cup-shaped portion of the sporangial wall with a wide apical pore or opening remains (Fig. 12).

In all cultures, there are invariably a small number of larger sporangia which are globose, up to 80 μm in diameter, or occasionally slightly irregular. These larger sporangia frequently possess a denser rhizoidal system and occasionally with a coiled main rhizoid. Zoospore discharge is through one or two wide pores or openings (Fig. 13).

The sporangial wall is smooth (as seen after zoospore release), two-layered and possibly thicker than in other species of *Piromyces*. There is an outer layer that is continuous with the main rhizoidal wall and an inner layer continuous with the septum. In sporangia following discharge, the two layers are occasionally separated (Fig. 14), and the septum can be seen as part of the inner layer. The persistence of the wall following discharge can be considered a distinctive characteristic of this species but the configuration of the layers, and continuity with the septum, cannot be ascertained until more species of both aerobic and anaerobic chytrids are studied with transmission electron microscopy. There are some differences in septum morphology between different species of chytrids. Powell (1974) reported that in the aerobic chytrid *Entophylyctis variabilis* Powell, a transverse septum forms by centripetal accumulation of material on the walls of the rhizoids where they join the sporangium (i.e. the port). In *Triparticalcar arcticum* Barr there is a ring of material, different in composition to the wall, that partially closes the port (Barr, 1970). In *Spizellomyces* spp. the neck port is open (Barr, 1984). In contrast, Heath *et al.* (1983) reported that in *Neocallimastix frontalis* a septum is laid down at sporogenesis, and that the septum is continuous with the sporangial wall. A similar continuity of septum and inner wall can be seen in the cellulolytic, aerobic chytrid *Rhizophlyctis rosea* (de Bary & Woronin) Fischer



Figs. 7-9. *P. minutus* with wide main rhizoid and more densely-branched rhizoidal system. The main rhizoid is sometimes coiled. Note the ends of the rhizoids are straight and moderately blunt. Fig. 10. Rhizoidal system with densely-branched rhizoids and tips of lateral rhizoids are rounded and slightly expanded. Bar = 20 μm.

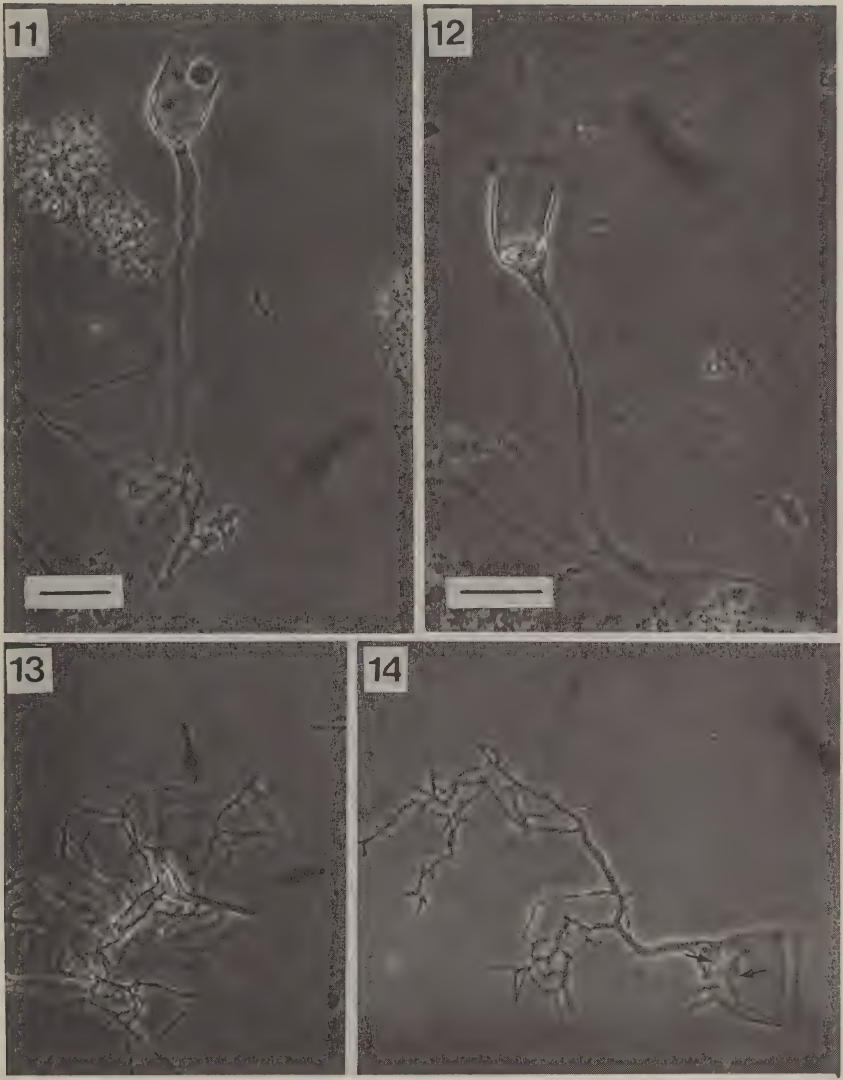


Fig. 11. Zoospores are released following the dissolution of a wide apical portion of the sporangial wall. Fig. 12. A persistent cup-shaped portion of the sporangium wall with a wide apical pore or opening after discharge of zoospores. Fig. 13. An empty sporangium with two wide pores or openings (arrows) through which zoospores are discharged. Fig. 14. An empty sporangium after release of zoospores showing a two-layed wall. The inner wall including the septum (arrows) is detached from the outer wall which is continuous with the main rhizoidal wall. Bar = 20μm.

(unpublished). The septum in *E. variabilis* has plasmodesmata whereas the septa in *N. frontalis* and *R. rosea* apparently do not. Further studies of walls and septa in the Chytridiomycetes may reveal homologies between the aerobic and anaerobic rumen taxa.

The presence of predominantly small sporangia each with a wide apical pore or opening is the conspicuous feature of *P. minutus* that distinguishes it from the other four species. In *P. communis* the zoospores are released following overall dissolution of the sporangial wall. For *P. mae* there are papillae that are thought to be products of localised wall softening possibly similar to the more complex papillae in other Spizellomycetales. Although rhizoid morphology is highly variable within species of Chytridiomycetes, the straight, unbranched main rhizoid terminating in a sparsely-branched rhizoidal system is very characteristic of *P. minutus*. This species also has strictly endogenous sporangium which separates it from *P. communis*. All these characteristics separate *P. minutus* from the other *Piromyces* species described and thus require it to be assigned to a new species.

Other isolates examined: Five other isolates obtained from the rumen contents of Timorensis deer *(Cervus timorensis)* at Universiti Pertanian Malaysia, Serdang, Malaysia, November - December, 1991, were also examined and their morphological characteristics conform to the above description.

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We thank Dr. J. Bisset for kindly providing the Latin translation of the diagnosis, and Professor A. Nawawi for reviewing the manuscript. We would also like to extend our thanks to Dr. M.K. Vidyadaran for providing the Sika and Timorensis deer.

REFERENCES

Barr, D.J.S. (1970). *Phlyctochytrium arcticum* n. sp. (Chytridiales) morphology and physiology. *Can. J. Bot. 48*, 2279-2283.

Barr, D.J.S. (1984). The classification of *Spizellomyces, Gaertneriomyces, Triparticalcar* and *Kochiomyces* (Spizellomycetales, Chytridiomycetes). *Can. J. Bot. 62*, 1171-1201.

Barr, D.J.S., Kudo, H., Jakober, K.D. & Cheng, K.-J. (1989). Morphology and development of rumen fungi: *Neocallimastix* sp., *Piromyces communis* and *Orpinomyces bovis* gen. nov., sp. nov. *Can. J. Bot. 67*, 2815-2824.

Breton, A., Dusser, M., Gaillard-Martinie, B., Guillot, J., Millet, L. & Prensier, G. (1991). *Piromyces rhizinflata* nov. sp., a strictly anaerobic fungus from faeces of the Saharian ass : a morphological, metabolic and ultrastructural study. *FEMS Microbiol. Lett. 82*, 1-8.

Gold, J.J., Heath, I.B. & Bauchop, T. (1988). Ultrastructural description of a new chytrid genus of caecum anaerobe, *Caecomyces equi* gen. nov. sp. nov., assigned to the Neocallimasticaceae. *BioSystems 21*, 403-415.

Heath, I.B., Bauchop, T. & Skipp, R.A. (1983). Assignment of the rumen anaerobe *Neocallimastix frontalis* to the Spizellomycetales (Chytridiomycetes) on the basis of its polyflagellate zoospore ultrastructure. *Can. J. Bot. 61*, 295-307.

Ho, Y.W. & Bauchop, T. (1991). Morphology of three polycentric rumen fungi and description of a procedure for the induction of zoosporogenesis and release of zoospores in cultures. *J. Gen. Microbiol. 137*, 213-217.

Ho, Y.W., Barr, D.J.S., Abdullah, N., Jalaludin, S. & Kudo, H. (1993). *Neocallimastix variabilis*, a new species of anaerobic fungus from the rumen of cattle. *Mycotaxon 46*, 241-258.

Li, J., Heath, I.B. & Bauchop, T. (1990). *Piromyces mae* and *Piromyces dumbonica*, two new species of uniflagellate anaerobic chytridiomycete fungi from the hindgut of the horse and elephant. *Can. J. Bot. 68*, 1021-1033.

Liebetanz, E. (1910). Die parasitischen protozoen der weiderkauermagens. *Arch. Protistenkunde 19*, 19-80.

Orpin, C.G. (1977). The rumen flagellate *Piromonas communis*: its life-history and invasion of plant material in the rumen. *J. Gen. Microbiol. 99*, 107-117.

Powell, M.J. (1974). Fine structure of plasmodesmata in a chytrid. *Mycologia 66*, 606-614.

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TYPE SPECIMENS OF LICHENS AND LICHENICOLOUS FUNGI IN THE CANADIAN MUSEUM OF NATURE (CANL)

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ABSTRACT

Type specimens of 737 lichen taxa and lichenicolous fungi (82 holotypes, 418 isotypes, 1 lectotype, 3 lectoparatypes, 22 isolectotypes, 13 syntypes, 13 isosyntypes, 176 paratypes, 6 isoparatypes and 3 isoneotypes) in the lichen herbarium of the Canadian Museum of Nature (CANL) are listed. The name of the taxon, authority, literature citation, category of type, locality information, collector, collector's number, collecting date and CANL accession number are recorded for each taxon, as well as, where applicable, exsiccat tittle and number, and currently accepted name.

With the recent reorganization of the Canadian Museum of Nature, a decision was made to upgrade the level of care for the herbarium and to register all the type specimens in the lichen collection (CANL). Since this collection is the largest in Canada and is one of the most important North American lichen herbaria, the job was given the highest priority.

The present catalogue lists in alphabetical order all type specimens of lichens and lichenicolous fungi preserved in the National Lichen Herbarium (CANL), which is housed at the Canadian Museum of Nature. Authority abbreviations for the epithets mainly follow Egan (1987) and its supplements (Egan 1989, 1990). References for the original descriptions are abbreviated according to Bridson (1991). The decision on whether or not a particular specimen is actually a type was made in the standard way, i.e., the label data were compared with the protologue, and annotations of the original author and subsequent annotators were considered. In some cases, the type status was indicated in some way on the labels, but this was not considered to be definitive. If the status of the type is in question, e.g., because of a discrepancy in the data, a query mark (?) is placed after the kind of type in the catalogue. The label data, including locality information, collector, collector's number and collecting date are cited more or less as originally written on the packet, with some standardisation, but the names of countries are given in English reflecting current political boundaries in so far as possible. The CANL accession number on the packet is also presented. If the type is part of a published exsiccata, the name of the series (with its author or distributor) and number are also given at the end of the entry. If paratypes occur in addition to other types or when there is more than one paratype specimen, only locality, collector, collector's number and CANL number are listed. No attempt has been made to revise all the types by including current synonyms, but where the type is known to be synonymous with another name, the currently accepted name is given.

I hope that this catalogue will be of assistance to lichenologists who need to locate type specimens required for their research. It may also help curators in other herbaria locate types in their collections which may have gone unnoticed.

This catalogue is not intended to be an authorative list of the type status of each specimen, nor can it be a definitive list of all the types now in CANL. As mentioned above, further study may reveal that some specimens in the list may not be types at all, and undoubtedly, some type specimens exist in CANL that have been overlooked. Each specialist must examine the evidence in order to decide the status of the listed specimens and other CANL material not in the list. Finally, it should be noted that in no case is any new typification of any epithet being proposed in this catalogue.

Acarospora canadensis H. Magn., Kongl. Svenska Vetensk. Acad. Handl. 7: 232 (1929).
ISOTYPE. Canada: Ontario. Near the Hog's Back, Rideau River. On limestone rocks. *J. Macoun 3646*, 2 May 1897 (CANL 11285).

Acarospora punae Lamb, Lilloa 14: 231 (1948).
ISOTYPE. Argentina: Prov. Tucuman, Valle de Tafi, western slope of Cumbre Potrerillo. On the overhung side of a large schistose rock. *I.M. Lamb 5290*, 20 November 1947 (CANL 11317).

Acolium bolanderi Tuck., Lich. of California p. 27 (1866).
ISOLECTOTYPE. United States: California, Oakland Hills. *H.N. Bolander 56*, 1864 (CANL 68772). Reliq. Tuck. No. 101.
= Thelomma mammosum (Hepp in Hartung) Massal.

Alectoria ambigua Mot., Bryologist 67: 17 (1964).
ISOPARATYPES. Canada: Newfoundland, Trinity North District, 2.5 miles NNW of Northern Bight Sta. Exposed rock outcrop in old fire-barren heath. *T. Ahti 592*, 15 August 1956. (CANL 52083); Placentia West, W of Swift Current, 2 miles NW of Long Pond. On big boulder in treeless heath. *T. Ahti 570*, 16

August 1956 (CANL 32344).
= Bryoria trichodes (Michx.) Brodo & D. Hawksw. subsp. americana (Mot.) Brodo & D. Hawksw.

Alectoria arctica Elenk. & Savicz, Trudy Glavn. Bot. Sada 32: 73 (1912).
ISOTYPE. Russia: Novaya Zemlya, sinus Krestovaja. *J.V. Palibin*, 1901 (CANL 104197).
≡ Evernia perfragilis Llano

Alectoria cornicularioides P. Jørg., Bryologist 78: 77 (1975).
ISOTYPE. China: Prov. Shensi, Kuan-tou-san. Among mosses. *G. Giraldi,* 1896 (CANL 60512).
= Bryoria cornicularioides (P. Jørg.) Brodo & D. Hawksw.

Alectoria corymbosa Hue, Expéd. Antarct. Franç. 1903-1905, p. 12 (1908).
ISOSYNTYPES. Antarctica: W. Graham Land (Palmer Peninsula) Wandel (Booth) Island. Sur les roches. *Expéd. Antarct. Franç. 272; 277* and *299*, 25 November 1904 (CANL 5707, 5708).
= Catillaria corymbosa (Hue) Lamb

Alectoria fuscescens Gyelnik, Nytt Mag. Naturvidensk 70: 55 (1932).
ISOLECTOTYPES. Finland: Tavastia austr., Hollola, ad truncos Pini locis apricioribus in silva. *J.P. Norrlin*, 18 September 1882 (CANL 29907 & 32345). Nyl. & Norrl.: Lich. Fenn. Exs. No. 466.
= Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.

Alectoria glabra Mot., Fragm. Florist. Geobot. 6: 448 (1960).
ISOTYPE. United States: Washington, Clallum Co., Hurricane Ridge, Olympic Peninsula. On trunk of *Abies lasiocarpa. B.I. Brown* & *W.C. Muenscher 129*, 24 July 1950 (CANL 28849).
=Bryoria glabra (Mot.) Brodo & D. Hawksw.

Alectoria imshaugii Brodo & D. Hawksw., Opera Bot. 42: 59 (1977).
HOLOTYPE. United States: Idaho, Benewah County, ca. 4.5 miles NW of St. Joe, top of St. Joe Baldy, near BLM Campground Tingley Spring area. On *Pseudotsuga menziesii* in open conifer stand. *G.J. Schroeder L1944*, 19 July 1971 (CANL 38827).
PARATYPES. United States: Calicornia, *I.M. Brodo 20489* & *20502*. (CANL 50581 & 50582). Oregon. *L.H. Pike 1475* (CANL 42730).

Alectoria mexicana Brodo & D. Hawksw., Opera Bot. 42: 62 (1977).
HOLOTYPE. Mexico: Oaxaca, Sierra de San Felipe, in pino. On pines. *C.G. Pringle 195*, 3 June 1894 (CANL 16582).
PARATYPES. Mexico: Oaxaca. *J. Beharrel* (CANL 55334, 55335 & 55342).

Alectoria stigmata Bystr., Fragm. Florist. Geobot. 20: 255

(1974).
ISOTYPE. United States: Alaska, Central Pacific Coast District, Kenai Peninsula, Creek Ridge. *H. Krog*, 28 May 1957 (CANL 54995).
= Alectoria sarmentosa (Ach.) Ach. subsp. sarmentosa.

Amagdalaria consentiens var. **japonica** M. Inoue, J. Hattori Bot. Lab. 56: 325 (1984).
ISOTYPE. Japan: Honshu, Pref. Nagano, Kiso-gun, Mitake-mura, Mt. Ontake. On rock. *M. Inoue 11474*, 17 August 1976 (CANL 92651).

Amygdalaria continua Brodo & Hertel, Herzogia 7: 505 (1987).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Moresby Island, Takakia Lake. At edge of water partially submerged. *I.M. Brodo 10880A*, 4 July 1967 (CANL 70598)
PARATYPES. Moresby Island. *I.M. Brodo 10880B, 10880D, 12804, 12819, 13960, 14288*. (CANL 70599, 70601, 70605, 70553, 36494 & 70603).

Amygdalaria haidensis Brodo & Hertel, Herzogia 7: 508 (1987).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Moresby Island, Tasu. On mined mountain behind Tasu camp, forest line. On summit rocks. *I.M. Brodo 12784*, 28 July 1967 (CANL 70594).
PARATYPES. Moresby Island. *I.M. Brodo 10834, 10933* & *14289*. (CANL 87857, 70604 & 70595).

Anaptychia fragilissima Kurok., Beih. Nova Hedwigia 6: 60 (1962).
ISOTYPE. Japan: Prov. Kii, Mt. Koya. On rocks. *S. Kurokawa 60238*, 17-18 December 1960 (CANL 20012). Kurokawa: Lich. Rar. Crit. Exs. No. 3.

Anaptychia japonica var. **reagens** Kurok., J. Jap. Bot. 35: 354 (1960).
ISOTYPE. Japan: Honshu, Prov. Sagami, Mt. Kintoki, Hakone. On trunk of trees. *S. Kurokawa 53064*, 26 April 1958 (CANL 26391). Kurokawa: Lich. Rar. Crit. Exs. No. 53.

Anthracothecium japonicum Kashiw. & Kurok., J. Jap. Bot. 56: 308 (1981).
ISOTYPE. Japan: Hokkaido, Prov. Ishikari, Noborikawa, Yubari-City. On bark of *Acer*. *H. Shibuichi 6067*, 4 August 1980 (CANL 78691). Kurokawa: Lich. Rar. Crit. Exs. No. 502.

Anzia afromontana R. Sant. in Moberg, Moberg: Lich. Sel. Exs. Ups., Thunbergia 2: 1 (1986).
ISOTYPE. Tanzania: Arusha Prov., Mt. Meru, ca. 2 km N of Kitoto Camp. On *Stoebe kilimandscharica*. *R. Santesson 22949*, 7 January 1971 (CANL 95077). Moberg: Lich. Sel. Exs. Ups. No. 1.

Arthopyrenia submuriformis R. Harris, Michigan Bot. 12: 15 (1973).
ISOTYPE. United States: Pennsylvania, West Chester. On bark

of hickory. *F. Windle*, July 1898 (CANL 19709). Cummings: Dec. N. Amer. Lich. No. 299.
= Strigula submuriformis (R. Harris) R. Harris

Arthopyrenia willeyana R. Harris, Michigan Bot. 12: 16 (1973).
ISOTYPE. United States: Michigan, Iosco County. In jackpine-aspen woods around Corsair State Forest Campground. *R.C. Harris 818*, 18 September 1965 (CANL 37273).
= Anisomeridium nyssaiegenum (Ellis & Everh.) R. Harris.

Aspicilia quartzitica W. Weber, Bryologist 74: 183 (1971).
ISOTYPE. United States: Colorado, Boulder County, outer foothills of the Front Range at Boulder. on resistant quartzite rocks of the Lyons formation, base of the first "Flatiron" on east face of Green Mountain. *W.A. Weber*, 24 January 1971 (CANL 52114). Weber: Lich. Exs. Colo. No. 364.

Bacidia colchica Vězda, Folia Geobot. Phytotax., Praha 14: 203 (1979).
ISOTYPE. Russia: Transcaucasia, Colchis. Distr. Gagra, in valle angusta rivi Zo Ekvara. Ad folia *Buxi colchicae*. *A. Vězda*, 13 June 1978 (CANL 73823). Vězda: Lich. Sel. Exs. No. 1660.

Bacidia lisowskii Vězda, Folia Geobot. Phytotax., Praha 15: 87 (1980).
ISOTYPE. Zaire: Haut-Zaire, Kisangani, prope vicum Batiambale. Ad folia arborum. *S. Lisowski*, 27 October 1976 (CANL 73852). Vězda: Lich. Sel. Exs. No. 1690

Bacidia nivalis Follm., Philippia 4: 30 (1978).
ISOTYPE. United States: Washington, Whatcom Co., fleckförmig an lichtoffenen, etwas windgeschützten, langfristig schneebedeckten Kulm- und Neigungsflächen niederer Felsblöcke und bodennaber Gesteinstrümmer im *Sporastatietum testudineae* Frey, im Bereich der Sommerschneegrenze am Nordosthang des Mount Baker über dem Austinpass. *G. Follmann*, July 1969 (CANL 69925). Follmann: Lich. Exs. Sel. No. 262.

Bacidia scutellifera Vězda, Folia Geobot. Phytotax., Praha 10: 421 (1975).
ISOTYPE. Tanzania: Distr. Morogoro, montes Nguru, in monte Mafulumula supra vicum Mnembule. Epiphylla in pluviisilva montana. *T. Pócs 6438*, 20-21 August 1971 (CANL 57290). Vězda: Lich. Sel. Exs. No. 1310.

Bacidia spirospora var. **patagonica** Lamb, Farlowia 4: 453 (1955).
HOLOTYPE. Argentina: Patagonia Prov. Chubut, Lago Cisnes near Lago Menendez. On trunk of *Colletia* at edge of the forest. *I.M. Lamb 5933*, 5.11.1950 (CANL 6024).

Bacidia vasakii Vězda, Folia Geobot. Phytotax., Praha 18: 64 (1983).
ISOTYPE. Russia: Colchis (Transcaucasia occid.), distr.

Adler, in valle angusta rivi Kudepsta, 5 km ab ostio in mare. Ad folia *Buxi colchicae*. *A. Vězda*, 19 June 1979 (CANL 85982). Vězda: Lich. Sel. Exs. No. 1869.

Bacidia violascens Kalb & Vězda, Folia Geobot. Phytotax., Praha 15: 309 (1980).
ISOTYPE. United States: Hawaii Insulae, Insula Kauai. Ad ramulos arboris (*Prosopis* sp. cult.). *O. Degener 34240*, 29 February 1977 (CANL 76382). Vězda: Lich. Sel. Exs. No. 1733.

Baeomyces weberi Thomson, Bryologist 73: 632 (1970).
ISOTYPE. Papua New Guinea: Morobe District, Mount Kaindi near Papua Wau. On clay banks of road-cuts not far below summit. *W.A. Weber*, 18 June 1968 (CANL 33497). Weber: Lich. Exs. Colo. No. 333.

Bahianora poeltii Kalb, Kalb: Lich. Neotr. Fasc. 8: 4 (1984).
ISOTYPE. Brazil: Bahia: Chapada Diamantina, Serra do Tombador; etwa 1 km vor der Stadt Morro do Chapeú. Am Grunde von Gräsern in einer Caatinga. *K. Kalb*, 20 July 1980 (CANL 89418). Kalb: Lich. Neotr. No. 302.

Bilimbia finkii Vainio, Mycologia 21: 35 (1929).
ISOTYPE. Puerto Rico: Rio Piedras. Open field on post. *B. Fink 534*, 12 January 1915 (CANL 5847).
≡ Bacidia finkii (Vainio) Zahlbr

Bryoria carlottae Brodo & D. Hawksw., Opera Bot.: 42: 101 (1977).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Graham Island, two mi. SE of Port Clements, S of the Tlell-Port Clements Road. *I.M. Brodo 18096*, 11 July 1971 (CANL 38266).
PARATYPES. Canada: British Columbia, Queen Charlotte Islands. *I.M. Brodo 9900, 10657B, 12879, 18093, 18499* & *18503B* (CANL 45536, 28902, 45490, 38264, 38265 & 42514).

Bryoria friabilis Brodo & D. Hawksw., Opera Bot.: 118 (1977).
ISOTYPE. United States: Washington, Gate. On oak trees. A.S. Foster, 14 October 1911 (CANL 36151).
PARATYPES. British Columbia. *I.M. Brodo 8179* (CANL 52607); *J. Macoun s.n.* & *77* (CANL 16156 & 16162); Quebec. *I.M. Brodo 18678* & *18691D* (CANL 37596 & 37587).

Bryoria pikei Brodo & D. Hawksw., Opera Bot. 42: 125 (1977).
HOLOTYPE. United States: Oregon, Marion Co.. Epiphyte in an old fruit orchard in a clearing in a douglas fir forest near Winter Falls in Silver Creek Falls State Park E of Salem. On young douglas fir. *L. Pike 2475*, 9 April 1972 (CANL 38271).
PARATYPES. Canada: British Columbia, Queen Charlotte Islands. *I.M. Brodo 12874A, 13839* & *18144A* (CANL 45543, 45510 & 38383); Nova Scotia. *J. Speer 73-24* (CANL 45159); United States: Oregon. *I.M. Brodo 20954* (CANL 99034); *L.H. Pike 1110* (CANL 48810); Washington. *I.M. Brodo 15438b* (CANL 32327); *L.H. Pike 844* (CANL 48821.

Bryoria pseudocapillaris Brodo & D. Hawksw., Opera Bot. 42: 126 (1977).
HOLOTYPE. United States: Oregon, Curry County, Cape Blanco, 8 miles N of Port Orford. On Sitka spruce at headland. *I.M. Brodo 20539*, 28 June 1974 (CANL 50596).

Bryoria salazinica Brodo & D. Hawksw., Opera Bot. 42: 130 (1977).
ISOTYPE. United States: Massachusetts, Springfield. *W.G. Farlow*, May 1878 (CANL 36152).
PARATYPES. Canada: Prince Edward Island. *J. Fabiszewski* (CANL 31266); *R.R. Ireland 10298* (CANL 35527).

Bryoria spiralifera Brodo & D. Hawksw., Opera Bot.: 42: 131 (1977).
HOLOTYPE. United States: California, Humboldt County. Pine forest near Manila. On *Pinus contorta*. *S. Dowty 137*, 22 January 1972 (CANL 38403).
PARATYPES. United States: California. *Brodo 20501, 20509* & *20511A* (CANL 50580, 50594 & 50578).

Buellia excellens H. Magn., Medd. Göteb. Bot. Trädg. 17: 69 (1947).
ISOTYPE. Argentina: Prov. Salta, Quebrada de San Lorenzo. *M. Digilio-Grassi 335*, 1946 (CANL 18205).
= Rhizocarpon compositum Lamb

Buellia galapagona W. Weber, Bryologist 74: 188 (1971).
ISOTYPE. Ecuador: Galápagos Islands, Isla Santa Cruz (Indefatigable I.), Academy Bay. On lava rocks along the shore of the bay just above high tide mark. *W.A. Weber*, 30 January 1964 (CANL 33508). Weber: Lich. Exs. Colo. No. 344.

Buellia imshaugii Hafellner, Beih. Nova Hedwigia 62: 58 (1979).
HOLOTYPE. Canada: South Saskatchewan. *J. Macoun*, 13 July 1879 (CANL 19326).
ISOTYPE. (CANL 19327).

Buellia multispora Kalb & Vězda, Folia Geobot. Phytotax., Praha 14: 203 (1979).
ISOTYPES. United States: Hawaii Insulae, Oahu, Keawaula Valley. On living trunks of exotic *Leucaena*. *O.* & *I. Degener 34257*, 16 March 1977 (CANL 73863). Vězda: Lich. Sel. Exs. No. 1670; (CANL 102697). Kalb: Lich. Neotr. No. 408.

Buellia rivas-martinezii Barreno & Crespo, Philippia 2: 283 (1975).
ISOTYPE. Spain: Prov. Madrid, zerstreut an stark geneigten kristallinen Gipsabbrüchen in licht-und windoffenen Trockenrasenlücken im *Lecideion gypsicolae* Crespo et Barr., 620 m. SO, Cerros Yesíferos de Valdemoro nördlich Aranjúez. *S. Rivas-Martínez* & *A. Crespo*, March 1972 (CANL 57049). Follmann: Lich. Exs. Sel. No. 143.

Buellia tephrodes Lamb, Farlowia 4: 468 (1955).

HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Lake Nahuel Huapí, Isla Victoria. On rocks at shore of lake, about 4 m above water level. *I.M. Lamb 5855 p.p.* (CANL 18365).

Buelliella eximia Kalb & Hafellner, Kalb: Lich. Neotr. Fasc. 11: 6 (1990).
ISOTYPE. Venezuela: Lara Prov., Distr. Torres, Etwa 35 km E von Barquisimeto. In einer trockenen Steppenlandschaft, parasitisch auf *Pyxine cocoes* (Sw.) Nyl. *K. & A. Kalb*, 10 August 1989 (CANL 102740). Kalb: Lich. Neotr. No. 452.

Buelliella physciicola Poelt & Hafellner, Beih. Nova Hedwigia 62: 155 (1979).
ISOTYPE. Czechoslovakia: Moravia austro-occidentalis, in valle fluminis Rokytná supra urbem Moravský Krumlov. In thallo *Physciae sciastrae* parasitice vigens, in rupibus conglomeraticis. *J. Poelt & A. Vězda*, 16 April 1974 (CANL 73837). Vězda: Lich. Sel. Exs. No. 1675.

Byssoloma amazonicum Kalb & Vězda, Nova Hedwigia 51: 437 (1990).
ISOTYPES. Brazil: Amazonas, Regenwälder am Rio Negro, zwischen 100-200 km oberhalb von Manaus. Foliicola in pluviisilva. *K. Kalb*, 14-18 October 1980 (CANL 103355). Vězda: Lich Sel. Exs. No. 2427; (CANL 103753). Kalb: Lich. Neotr. No. 482.

Byssoloma anomalum Kalb & Vězda, Nova Hedwigia 51: 438 (1990).
ISOTYPE. Brazil: Amazonas, Regenwälder am Rio Negro, zwischen 100-200 km oberhalb von Manaus. *K. Kalb*, 14-18 October 1980 (CANL 103754). Kalb: Lich. Neotr. No. 483.

Calicium adspersum subsp. **australe** Tibell, Publ. Herb. Univ. Uppsala 12: 1 (1984).
ISOTYPE. Australia: Tasmania, Ben Lomond National Park, 32 km E of Evansdale, along Ben Lomond Road, 1 km NW of Carr Villa. On decorticated, dead but still standing trunk of *Eucalyptus* sp. *L. Tibell 11465*, 14 March 1981 (CANL 87449). Tibell: Caliciales Exs. No. 76.

Calicium constrictum Tibell, Lichenologist 14: 223 (1982).
ISOTYPE. Costa Rica: Puntarenas, on old Camino Real, 3.5 km SE of Paso Real. On bark of roadside fence-post. *L. Tibell 8233*, 30 December 1978 (CANL 87450). Tibell: Caliciales Exs. No. 77.

Calicium cryptocroceum Tibell, Publ. Herb. Univ. Uppsala 10: 1 (1982).
ISOTYPE. New Zealand: Canterbury, 9.5 km SSE of Arthur's Pass, Bealy Spur, along track to Grasmere Hut. On decorticated stump of *Nothofagus solanderi* v. *cliffortioides*. *L. Tibell 10084*, 17 December 1980 (CANL 82033). Tibell: Caliciales Exs. No. 51.

Calicium curtisii var. **splendidula** G. K. Merrill, Bryologist

12: 107 (1909).
ISOTYPE. United States: Maine, Knox County, Rockland. On *Rhus typhina*. *G.K. Merrill*, 3 May 1909 (CANL 20271). Merrill: Lich. Exs. No. 24.
= Phaeocalicium curtisii (Tuck.) Tibell.

Calicium fuscipes Tuck., Genera Lichenum p. 240 (1872).
SYNTYPE. United States: New Jersey, Closter. *C.A. Austin*, November 1864 (CANL 68717). Reliq. Tuck. No. 22.
= Mycocalicium fuscipes (Tuck.) Fink

Calicium obscurum G. K. Merrill, Bryologist 12: 107 (1909).
ISOTYPE. United States: Maine, Rockland. On dead fungus. *G.K. Merrill*, 5 September 1909 (CANL 20337). Merrill: Lich. Exs. No. 92.
= Chaenotheca brunneola (Ach.) Müll. Arg.

Calicium parvum Tibell, Symb. Bot. Upsal. 21: 84 (1975).
ISOTYPE. Canada: Ontario, Renfrew County, Petawawa Forest Experiment Station, not far from Mill Lake. On trunk of *Picea* in a swamp. *L. Tibell 4638*, 21 August 1972 (CANL 55417).

Caloplaca bisagnonis B. de Lesd., Bull. Soc. Bot. France 98: 137 (1951).
ISOTYPE. Italy: Genova, Val Bisagno, Prato. *Sbarbaro*, 21 April 1951 (CANL 17465).

Caloplaca brattiae W. Weber, Graphis Scripta 2: 168 (1989).
ISOTYPE. United States: California, Santa Barbara County, Channel Islands, Santa Cruz Island. West end of the island. On top of the rocky headland just above the spray zone. *W.A. Weber* & *C. Bratt,* 8 January 1986 (CANL 97959). Weber: Lich. Exs. Colo. No. 660.

Caloplaca britannica R. Sant., Lichenologist 24: 2 (1992).
ISOTYPE. Scotland: Caithness (V. C. 109), Crosskirk Bay, c. 10 km W of Thurso. On seashore rocks. *R. Santesson 20410*, 18 July 1969 (CANL 104124).

Caloplaca citrina var. **arcis** Poelt & Vězda, Vězda: Lich. Sel. Exs. Fasc. 99: 6 (1990).
ISOTYPE. Austria: Stiria, Distr. Feldbach, Riegersburg. Ad saxa andesitica sub arcem. *G. Kantvilas, H. Mayrhofer* & *A. Vězda*, 22 September 1990 (CANL 103398). Vězda: Lich. Sel. Exs. No. 2470.

Caloplaca fraxinea Lamb, Rep. (Annual) Natl. Mus. Canada, Bull. 132: 304 (1954).
HOLOTYPE. Canada: Nova Scotia, Cape Breton Island, at Baddeck. On black ash bark in a swamp. *J. Macoun 1737*, 8 July 1898 (CANL 17744).

Caloplaca hensseniana Kalb, Kalb: Lich. Neotr. Fasc. 11: 7 (1990).
ISOTYPE. Venezuela: Lara Prov. Distr. Iribarreno, etwa 15 km E von Barquisimeto. Epiphytisch in trockener Steppen-

Vegetation, untermischt mit Cacteen. *K. & A. Kalb*, 20 August 1989 (CANL 102742). Kalb: Lich. Neotr. No. 454.

Caloplaca litoricola Brodo, Bryologist 87: 98 (1984).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Graham Island, Tow Hill. On shoreline rocks. *I.M. Brodo 9905*, 16 June 1967 (CANL 85435). Brodo: Lich. Canad. Exs. No. 156.

Caloplaca marina subsp. **americana** Arup, Bryologist 95: 158 (1992).
ISOTYPE. United States: Oregon, Lincoln County, Rocky Creek Wayside State Park, just south of Whale Cove. On volcanic seashore rocks. *U. Arup 89189*, 19 April 1989 (CANL 103721).

Caloplaca sbarbaronis B. de Lesd., Bull. Soc. Bot. France 96: 173 (1949).
ISOTYPE. Italy: Liguria orientalis, Bonassola. Rupicola prope mare. *Sbarbaro*, February 1949 (CANL 17859).

Caloplaca sorediata var. **tenuis** H. Magn., Ark. Bot. 33A: 134 (1946).
SYNTYPE. Sweden: Lycksele Lappmark, par. Stensele, Kyrkberget. Under overhanging rocks. *A.H. Magnusson 7841*, 5 July 1924 (CANL 17873).
= Xanthoria sorediata (Vainio) Poelt

Caloplaca spotornonis B. de Lesd., Bull. Soc. Bot. France 100: 177 (1953).
ISOTYPE. Italy: Savona, Spotorno, loco "Monte". *Sbarbaro*, December 1951 (CANL 17876).

Caloplaca trabicola H. Magn., Medd. Göteb. Bot. Trädg. 18: 219 (1950).
PARATYPE. Uruguay: Florida Prov., Estancia, 25 de Agosto. Sobre postes de alambrado. *H.S. Osorio 1752*, 22 November 1949 (CANL 17887).

Candelariella faginea Nimis & Poelt, Nova Hedwigia 49: 276 (1989).
ISOTYPE. Italy: Calabria, Serra del Prete, loco Massiccio del Pollino dicto. Ad corticem *Fagi*. *P.L. Nimis & J. Poelt*, 10 July 1988. (CANL 100651). Vězda: Lich. Sel. Exs. No. 2377.

Candelariella hudsonica Hakul., Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 27: 49 (1954).
HOLOTYPE. Canada: Northwest Territories, Franklin District. On earth, north shore of Hudson Strait. *R. Bell 1660*, August 1897 (CANL 12961).
= Candelariella canadensis H. Magn.

Candelariella lambii Hakul., Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 27: 49 (1954).
HOLOTYPE. Argentina: Prov. Tucumen, Valle de Tafi, west slope of Cumbre Potrerillo. On the top of a block of schistose rock in alpine pasture. *I.M. Lamb 5413*, 24 November 1947 (CANL 12962).

Candelariella plumbea Poelt & Vězda, Folia Geobot. Phytotax., Praha 11: 88 (1976).
ISOPARATYPE. Austria: Karawanken, Kärnten, Kanzianiberg bei Finkenstein SE Villach, W- bis S-sei- tige Abbrüche. *J. Poelt*, 10 February 1974 (CANL 73768). Poelt: Pl. Graecenses No. 137.

Catapyrenium caeruleopulvinum Thomson, Bryologist 90: 30,1987.
ISOTYPE. United States: California, San Bernardino, 2 miles SW of Parker Dam near the Colorado River. On soil. *T.H. Nash 8449*, 26 February 1974 (CANL 52409).
PARATYPE. United States: Arizona. *T.H. Nash 8047*. (CANL 52394).

Catillaria italica B. de Lesd., Bull. Soc. Bot. France 97: 170 (1950).
ISOTYPE. Italy: Rapallo (Genova), Loco opaco infra Montallegro, ad maceriam. *Sbarbaro*, November 1949 (CANL 5758).

Catillaria melanopotamica Lamb, Farlowia 4: 445 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Lake Nahuel Huapi, Isla Victoria. On trunk of *Nothofagus dombeyi*. *I.M. Lamb 5815*, 26 January 1950 (CANL 5769).
PARATYPE. Argentina: Isla Victoria. *I.M. Lamb 5836* (CANL 5768).

Cetraria alaskana C. Culb. & Culb., Bryologist 69: 200 (1966).
ISOTYPE. United States: Alaska, Along the Pitmegea River, 15 miles upstream from Cape Sabine. On wet tundra. *J.W. Thomson*, 10-17 July 1958 (CANL 20583). Thomson: Lich. Arct. No. 13.
= Cetrelia alaskana (C. Culb. & Culb.) Culb. & C. Culb.

Cetraria australiensis W. Weber ex Kärnef., Bot. Not. 130: 127 (1977).
ISOTYPE. Australia: New South Wales, Snowy Mountains, Kosciusko State Park. *W.A. Weber* & *D. McVean*, 2 February 1968 (CANL 52204). Weber: Lich. Exs. Colo. No. 454.

Cetraria fendleri f. **coralligera** W. Weber, Univ. Colorado Stud., Ser. Biol. 10: 11 (1963).
ISOTYPE. United States: Colorado, Larimer County, Lumpy Ridge nächst Twin Owls an der Route zum Gem Lake, 1.5 Meilen N Lake Estes. *R.A. Anderson*, 27 August 1962 (CANL 71724). Crypt. Exs. Vindob. No. 4439.
= C. coralligera (W. Weber) Hale

Cetraria iberica Crespo & Barreno, Anales Jard. Bot. Madrid 37: 205 (1980).
ISOTYPE. Spain: Guadalajara, Tamajón. Ad *Cistus ladaniferus*. *A. Crespo* & *E. Barreno*, May 1977 (CANL 78851). Vězda: Lich. Sel. Exs. No. 1752.

Cetraria islandica var. **arborialis** Zahlbr., Cat. Lich. Univ.

6: 333 (1930).
LECTOTYPE. Canada: British Columbia, Glacier, Marion Lake. On bushes. *J. Macoun*, 23 August 1904 (CANL 15550).
= C. subalpina Imsh.

Cetraria subalpina Imsh., Mycologia 42: 746 (1950).
ISOTYPE. United States: Washington, Mt. Rainier National Park, Mt. Wow. On branches of small shrubs. *H.A. Imshaug 1876*, 21 August 1948 (CANL 15549).
PARATYPES. Mt. Rainier National Park. *H.A. Imshaug 261* & *267* (CANL 15551, 15552); Cataract Falls. H.A. Imshaug 510 (CANL 24532).

Chaenothecopsis nana Tibell, Publ. Herb. Univ. Uppsala 4: 4 (1979).
PARATYPE. Sweden: Värmland, Norra Finnskoga par., N of Digerfallet. On trunk of *Picea abies*. *S. Sundell 13382*, 16 August 1979 (CANL 71126). Tibell: Caliciales Exs. No. 35.

Chaenothecopsis nigropedata Tibell, Symb. Bot. Upsal. 27: 135 (1987).
ISOTYPE. New Zealand: South Island, Southland, Longwood State Forest, 19 km NNW of Riverton, along Pourakino River, N of Pourakino Campground. On decorticated stump. *L. Tibell 10428*, 16 January 1981 (CANL 99793). Tibell: Caliciales Exs. No. 160.

Chaenothecopsis sagenidii Tibell, Symb. Bot. Upsal. 27: 148 (1987).
ISOTYPE. New Zealand: Otago, 15 km WNW of Owaka, Catlins Forest, along Catlins River, S of the junction with Chloris stream. On still corticated parts of decaying stump of *Nothofagus menziesii*. *L. Tibell 10282*, 11 January 1981 (CANL 99795). Tibell: Caliciales Exs. No. 162.

Chaenothecopsis tasmanica Tibell, Publ. Herb. Univ. Uppsala 16: 6 (1985).
ISOTYPE. Australia: Tasmania, Mt. Field National Park, W shore of Lake Dobson. On dead leaves of *Richea pandanifolia*. *L. Tibell 11117*, 5 March 1981 (CANL 89742). Tibell: Caliciales Exs. No. 118.

Charcotia rufidula Hue, Bull. Soc. Bot. France 62: 17 (1915).
ISOTYPE. Antarctica: Graham Land (Palmer Peninsula), Booth (Wandel) Island. *Deux Exped. Antarct. France 123*, October 1908. (CANL 10604).
= Arthonia rufidula (Hue) D. Hawksw., R. Sant. & Øvstedal (1991).

Cheiromycina petri D. Hawksw & Poelt, Lichenologist 22: 219 (1990).
ISOTYPE. Austria: Styria, in collibus "Oststeierisches Hügelland", distr. Feldbach, Lamberg, in pago Petersdorf II. Ad corticem trunci *Betulae*. *J. Poelt* & *H. Pittoni*, 27 November 1987 (CANL 103356), Vězda: Lich. Sel. Exs. No. 2428.

Cladina conspicua Ahti, Ann. Bot. Fenn. 23: 224 (1986).
ISOTYPE. Canada: Newfoundland, Humber East District, ca. 2.4 km N of Gaff Topsail, timberline heath. *T. Ahti 2997*, 27 June 1956 (CANL 96933).
PARATYPE. Canada: Newfoundland, St. Mary District. *T. Ahti 9461.* (CANL 96934).

Cladonia alpestris f. **aberrans** des Abb., Bull. Soc. Sci. Bretagne 16, Fasc. hors sér. 2: 93 (1939).
ISOLECTOTYPE. United States: Alaska, St. Paul Island. *J. Macoun*, 26 June 1897, (CANL 6540). Macoun: Canad. Lich. No. 171.

Cladonia anitae Culb. & C. Culb., Mycologia 74: 663 (1982).
ISOTYPE. United States: North Carolina, Onslow Co., inter Folkstone et Holly Ridge. Ad terram arenariam. *W.L. Culberson 18539*, 1 April 1981 (CANL 85967). Vězda: Lich. Sel. Exs. No. 1854.

Cladonia arbuscula subsp. **beringiana** Ahti, Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 32: 109 (1961).
ISOTYPE. Canada: Northwest Territories, Mackenzie District, Great Bear Lake, at head of Great Bear River where it flows out of Great Bear Lake. *A.A. Lindsey 417*, 23 July 1951 (CANL 9766).
= Cladina arbuscula (Wallr.) Hale & Culb. subsp. beringiana (Ahti) Golubk.

Cladonia boliviana Ahti, Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 32: 131 (1961).
ISOTYPE. Bolivia: La Paz, 10,000 ft. *M. Bang 20a (20* on holotype), 1889. (CANL 59522).
= Cladina boliviana (Ahti) Ahti

Cladonia convoluta var. **vagans** Follm., Philippia 2: 208 (1975).
ISOTYPE. Spain: Prov. Teruel. Zwergstrauchheide in der Sierra de la Costera unweit Fuentes Calientes. *G. Follmann*, July 1973 (CANL 57051). Follmann: Lich. Exs. Sel. No 145.

Cladonia crispata var. **infundibulifera** f. **albopunctata** G. K. Merrill, Bryologist 11: 110 (1908).
SYNTYPES. Canada: Yukon, Hunker Creek. In bogs. *J. Macoun 104* & *108*, 28 July 1902 (CANL 7411 & 7382).
= C. crispata (Ach.) Flotow var. cetrariiformis (Delise) Vainio (fide T. Ahti)

Cladonia favillicola Trass, Investigationes Naturae Orientis Extremis (Tallinn) p. 198 (1963).
ISOTYPE. Russia: Kamczatka, 20 km a Kozyrevsk in SO, ad flumen Pahtza, in lariceto-ledose, ad laricis truncum prolapsum crasso strato ex favilla vulcanica et aculeis laricis tectum. *H. Trass*, 23 August 1960 (CANL 57970).
= C. botrytes (K. Hagen) Willd.

Cladonia gracilis subsp. **vulnerata** Ahti, Ann. Bot. Fenn. 17:

207 (1980).
ISOTYPE. United States: Alaska, Chugach Mts., Blueberry Lake Campground, Mile 23, Richardson Hwy. In montane tundra. *T. Ahti & J.W. Thomson 23642*, 25-26 July 1967 (CANL 75105).
PARATYPES. Canada: British Columbia. *I.M. Brodo 9760 & 18156*. (CANL 31098 & 61622).

Cladonia hedbergii Ahti, Lichenologist 9: 4 (1977).
ISOTYPE. Kenya: Central Prov., Nanyuki Distr., Mt. Kenya, National Park Road (Naro Moru Track). On the ground in a wet slope in the *Hagenia-Hypericum* zone. *R. Santesson "32495" (22040* in protologue), 23 January 1970 (CANL 99586). Moberg: Lich. Sel. Exs. Upsal. No. 56.

Cladonia kauaiensis G. K. Merrill, Ark. Bot. 31A(6): 28 (1944).
ISOLECTOTYPE. United States: Hawaiian Islands, Kauai. On earth. *A.A. Heller,* 10-16 September 1895 (CANL 20334). Merrill: Lich. Exs. No. 89.

Cladonia labradorica Ahti & Brodo, Bryologist 84: 238 (1981).
HOLOTYPE. Canada: Québec, Post-de-la-Baleine, 8 milles de la mer (Baie d'Hudson). A. Vachon, 20 August 1974 (CANL 71500).
PARATYPES. Canada: Quebec. *J.P. Ducruc 73-4062* (CANL 49135); *G. Lemieux 21399* (CANL 70052); *J.L. Lethiecq QFB-E 4495 & 4497* (CANL 48848 & 48881).

Cladonia libifera Savicz, Novosti Sist. Nizših Rast. 1965: 167 (1965).
ISOTYPE. Russia: Sibiria orientalis, Respublica autonoma Jakutensis, in valle fluminis Aldan, prope Chandyga apud fontem "Tjoply kljucz' in lariceto ad truncum putridum. *L.N. Tjulina*, 1949 (CANL 48266).
= C. pocillum (Ach.) O. Rich.? (fide T. Ahti)

Cladonia magyarica Vainio, Fl. Hung. Exs. No. 715 (1927).
ISOLECTOTYPE. Hungary: Comit, Pest Prov., "Bugaci nagyerdö" prope oppidum Kecskemét. Ad arenam mobilem in silva. *G. Timkó*, May 1924 (CANL 19843).

Cladonia norvegica Tønsberg & Holien, Nordic J. Bot. 4: 79 (1984).
ISOTYPE. Norway: Sør-Trøndelag, Melhus, inter montem Loåsen et rivulum Loa. Ad basin abscisam arboris (*Picea abies*). *T. Tønsberg 6870*, 5 June 1982 (CANL 89184). Vězda: Lich. Sel. Exs. No. 1978.

Cladonia patagonica A. Evans, Rev. Bryol. Lichénol. 24: 135 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Menéndez, W. end. *I.M. Lamb 5886*, 2 February 1950 (CANL 9081).
= C. squamosa (Scop.) Hoffm. (barbatic acid chemotype) (fide T. Ahti 1992).

Cladonia physodalica Elix, Lich. Austral. Exs. Fasc. 9, No. 204 (1990).

ISOTYPE. Australia: Queensland, Main Coast Range, Mt. Lewis Track, Mary Creek, 15 km NNW of Mt. Molloy. On soil on large boulder. *J.A. Elix 16947*, 30 June 1984 (CANL 102793). Elix: Lich. Austral. Exs. No. 204.
= C. poecilocladа des Abb.(physodalic acid chemotype) (fide T. Ahti 1992).

Cladonia rangiferina f. **caerulescens** Schade, Ber. Deutsch. Bot. Ges. 69: 284 (1956).
ISOTYPE. Canada: Manitoba, Oxford Lake. *H.J. Scoggan 60*, 3 July 1949. (CANL 9394).
= Cladina stygia (Fr.) Ahti

Cladonia rangiferina f. **leucosticta** G. K. Merrll, Bryologist 11: 109 (1908).
SYNTYPES. Canada: Yukon, Hunter Creek. In a bog. *J. Macoun 112 & 113* (CANL 9141 & 9140).
= C. wainii Savicz (fide T. Ahti)

Cladonia subchordalis A. Evans, Rev. Bryol. Lichénol. 24: 133 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Chubut, w. end of Lago Menéndez, Torrecillas Stream. On mossy soil between morainic boulders. *I.M. Lamb 5917*, 4 February 1950 (CANL 9671).

Cladonia terrae-novae Ahti, Arch. Soc. Zool.-Bot. Fenn. "Vanamo" 14: 131 (1960).
ISOTYPE. Canada: Newfoundland: Placentia West District, 4 miles NW of Long Pond. *T. Ahti 108*, 16 August 1956 (CANL 58385).
= Cladina terrae-novae (Ahti) Hale & Culb.

Cladonia terrae-novae f. **cinerascens** Ahti, Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 32: 82 (1961).
ISOTYPE. Canada: Newfoundland, Placentia West District, 2 mi. NW of Long Pond. *T. Ahti 7*, 17 August 1956 (CANL 58408).
= Cladina terrae-novae (Ahti) Hale & Culb. f. cinerascens (Ahti) Brodo

Cladonia thomsonii Ahti, Bryologist 81: 334 (1978).
ISOPARATYPE. United States: Northern Alaska, on the point of Point Barrow. *J.W. Thomson, S. Shushan & A.J. Sharp*, 18 July 1958 (CANL 20591). Thomson: Lich. Arct. No. 21.

Cliostomum luteolum Gowan, Mycologia 82: 769 (1990).
HOLOTYPE. Canada: New Brunswick, Albert Co., Fundy National Park, Point Wolfe. On *Picea rubens*. *S.P. Gowan 3836*, 1 August 1980 (CANL 82486).

Cliostomum vitellinum Gowan, Mycologia 82: 769 (1990).
PARATYPE. Canada: New Brunswick, Westmoreland Co., near Sackville, Johnson's Mills. On trunk of *Abies balsamea*. *M. Fredericksen 78008*, 1 February 1978 (CANL 67236).

Coccocarpia stellata Tuck., Proc. Amer. Acad. Arts. 5: 402 (1862).

ISOTYPE. United States: South Carolina, Santee Canal. *H.W. Ravenel 250* (CANL 68742). Reliq. Tuck. No. 63.

Coccotrema maritimum Brodo, Bryologist 76: 263 (1973).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Moresby Island, Jedway. On shoreline rocks. *I.M. Brodo 12459*, 25 July 1967 (CANL 30581).
PARATYPES. Canada: British Columbia. *I.M. Brodo 14355* (CANL 30862); *K.E. Ohlsson 1011, 1023, 1050, 1059, 1173, 2116* & *2448* (CANL 32299, 32300, 32295, 32296, 32298, 32297 & 32301); *G.F. Otto 1504* (CANL 36507); *M.J. Shchepanek 253* (CANL 30876).

Collema microptychium Tuck., Lich. Calif.: 35 (1866).
ISOLECTOTYPE. United States: Massachusetts, Amherst, Parttrigg's Swamp. *E. Tuckerman*, 1861 (CANL 23165).
= C. leptaleum Tuck.

Coniocybe amabilis Tibell, Publ. Herb. Univ. Uppsala 10: 6 (1982).
ISOTYPE. New Zealand: Wellington, Tongariro National Park, 3 km NE of Ohakune, along Mountain Road. On decorticated stump of *Dacrydium cupressinum*. *L. Tibell 13605*, 3 June 1981 (CANL 82046). Tibell: Caliciales Exs. No. 65.

Conotremopsis weberiana Vězda, Folia Geobot. Phytotax., Praha 12: 314 (1977).
ISOTYPE. Australia: Tasmania, Lake St. Clair National Park. On saplings near shore of Lake St. Clair at beginning of trail to Mt. Hugel. *W.A. Weber & D. McVean 49678*, 24 February 1968 (CANL 92385).

Dactylina beringica Bird & Thomson, Canad. J. Bot. 56: 1612 (1978).
ISOTYPE. Canada: British Columbia, Summit Lake. Mile 392.5, Alaska Hwy, slope of Mt. George. *J.W. Thomson & T. Ahti 16553*, 13 August 1967 (CANL 59778).

Dermatocarpon corticola ("corticolum") Räsänen, Anales Soc. Ci. Argent. 128: 147 (1939).
ISOTYPE. Uruguay: Dept. Artigas, Sucio. On bark of trees. *W.G. Herter*, 1934 (CANL 1063).

Dermatocarpon gorzegnoense Servít, Ann. Mus. Civico Storia Nat. Giacomo Doria 66: 242 (1953).
ISOTYPE. Italy: Piemonte, Langhe, Gorzegno. *Sbarbaro*, September 1951 (CANL 1081).

Dermatocarpon vagans Imsh., Mycologia 42: 753 (1950).
ISOTYPE. United States: Wyoming, NE corner of Yellowstone National Park. On arid soil. *H.A. Imshaug 15*, 23 June 1948 (CANL 1185).

Dimerella chiodectonoides Kalb, Kalb: Lich. Neotr. Fasc. 10: 7 (1988).
ISOTYPE. Ecuador: Azuay Prov., etwa 35 km südlich von Cuenca.

In sehr dichten, feuchten Waldresten in einem Graspáramo. *K. & A. Kalb*, 26 August 1987 (CANL 102706). Kalb: Lich. Neotr. No. 417.

Dimerella degeneri Kalb & Vězda, Folia Geobot. Phytotax., Praha 15: 310 (1980).
ISOTYPE. United States: Hawaii Insulae, Insula Oahu, Kaukonahua Gulch prope territorium Universitatis. Ad corticem arboris (*Ficus* sp. cult.). *O.* et *I. Degener 34269*, 17 May 1977 (CANL 76378). Vězda: Lich. Sel. Exs. No. 1729.

Dimerella frederici Kalb, Folia Geobot. Phytotax., Praha 15: 310 (1980).
ISOTYPES. United States: Hawaii, island Hawaii, Kilauea, Kau Desert. On bark of naturalized *Samanea saman*. *O.* et *I. Degener 34230*, 1 February 1977 (CANL 76379, 77581, 77633, and 102708). Vězda: Lich. Sel. Exs. No. 1730; Poelt: Pl. Graecenses No. 200; Follmann: Lich. Exs. Sel. No. 343; Kalb: Lich. Neotr. No. 419.

Dimerella isidiigera Vězda & Osorio, Vězda: Lich. Sel. Exs. Fasc. 94: 2 (1989).
ISOTYPE. Uruguay: Montevideo, Parque Rivera. Ad corticem *Cupressi* loco umbroso. *H.S. Osorio*, 12 October 1988 (CANL 100603). Vězda: Lich. Sel. Exs. No. 2329.

Dimerella pocsii Vězda & Farkas, Folia Geobot. Phytotax., Praha 23: 193 (1988).
ISOTYPE. Tanzania: Tanga regio, Usambara Orientalis, reservatum naturae Kihuhwi Forest dictum, secus trametem inter Kihuhwi et Wamkoro. Foliicola in pluviisilva. *E. Farkas 86228*, 3 November 1986 (CANL 97332). Vězda: Lich. Sel. Exs. No. 2230.

Dimerella subdentata Vězda & Thor, Vězda: Lich. Sel. Exs. Fasc. 94: 3 (1989).
ISOTYPE. Australia: Queensland, circa 15 km ad occidentem et septentriones a Tully prope litorem Mission, secus Stony Creek. Ad corticem arboris in pluviisilva. *G. Thor 5721*, 28 November 1985 (CANL 100607). Vězda: Lich. Sel. Exs. No. 2333.

Dimerella subfallaciosa Vězda & Farkas, Vězda: Lich. Sel. Exs. Fasc. 98: 2 (1990).
ISOTYPE. Tanzania: Regio Morogoro, montes Nguru, in valle "Dikurura", 3 km ad orientem a "Mhonda Mission". In pluviisilva montana. *E. Farkas 89100*, 22 March 1989 (CANL 103357). Vězda: Lich. Sel. Exs. No. 2429.

Dimerella usambarensis Vězda & Farkas, Folia Geobot. Phytotax., Praha 23: 196 (1988).
ISOTYPE. Tanzania: Tango regio, Usambara Orientalis, reservatum naturae Marvera Forest dictum, 6 km ad septentriones et orientem ab Amani. Foliicola. *E. Farkas* & *T. Pócs 86228*, 12 December (November in protologue) 1986 (CANL 97333). Vězda: Lich. Sel. Exs. No. 2231.

Diploschistes montevidensis H. Magn., Medd. Göteb. Bot. Trädg. 18: 223 (1950).
ISOTYPE. Uruguay: Montevideo, Pajas Blancas. Sobre la tierra. *H.S. Osorio 1621*, 20 February 1949 (CANL 2236).
= D. conceptionis Vainio

Diploschistes sbarbaronis B. de Lesd., Bull. Soc. Bot. France 99: 147 (1952).
ISOTYPE. Italy: Toscana, Siena, Latericola in villa Solaia (Monteliscai). *Sbarbaro*, May 1951 (CANL 2241).
= D. actinostomus (Pers. ex Ach.) Zahlbr.

Diploschistes straminescens Zahlbr., Mycologia 22: 71 (1930).
ISOLECTOTYPE. Puerto Rico: Mayaguez. Open road-side on clay bank. *B. Fink 1016*, 18 December 1915 (CANL 2279).
= D. hypoleucus Zahlbr.

Dirina californica Tuck., Lich. Calif. p. 422 (1866).
ISOLECTOTYPE. United States: California, Oakland. *H.N. Bolander 129*, 1866 (CANL 68755).
= Schismatomma californicum (Tuck.) Zahlbr.

Dolichocarpus chilensis R. Sant., Svensk Bot. Tidskr. 43: 552 (1949).
ISOTYPE. Chile: Prov. Coquimbo, Coquimbo. On spines of *Cereus* in dry hill near the sea-shore. *R. Santesson 2620a*, 1 August 1940 (CANL 2113).

Endocarpon mailae Lamb, Lilloa 14: 213 (1948).
PARATYPE. Argentina: Prov. Tucumán, Sierra de Javiev, E. side. On rocks at roadside. *I.M. Lamb 5096*, 14 September 1947 (CANL 1197).

Endocarpon tuckermanii Rav. ex Mont., Sylloge Gener. Spec. Cryptog.: 359 (1856).
ISOTYPE. United States: South Carolina, Santee Canal. On *Carya* sp. among mosses. *H.W. Ravenel 138* (CANL 1180). Reliq. Tuck. No. 42.
= Catapyrenium tuckermanii (Rav. ex Mont.) Thomson

Evernia perfragilis Llano, J. Wash. Acad. Sci. 41: 199 (1951).
(see Alectoria arctica Elenk. & Savicz).

Everniastrum fragile Sipman, Proc. Kon. Ned. Akad. Wetensch. Ser. C. 83: 348 (1980).
ISOTYPE. Colombia: Caldas, below hotel Termales, Nevado del Ruíz. On grazed secondary shrub vegetation. *H. Sipman & H. Valencia 10512*, 4 February 1979 (CANL 91358). Hale: Lich. Amer. Exs. No. 235.

Fellhanera endopurpurea Hafellner & Vězda, Nova Hedwigia 52: 76 (1991).
ISOTYPE. Australia: New South Wales, Border Ranges National Park, Wiangaree, Brindle Creek. Foliicola in silva (*Nothofagus moorei*). *J. Hafellner, P. Merotsy & R. Rogers*, 30

August 1986 (CANL 103382). Vězda: Lich. Sel. Exs. No. 2454.

Fulgensia canariensis Follm. & Poelt, Philippia 4: 370 (1981).
ISOTYPE. Canary Islands: Tenerife, kleinfeldrig auf lichtoffenen, weitgehend ebenen oder mässig geneigten flachgründigen Lössinseln zwischen Hartlaubsträuchern auf Bergrücken im *Diploschistetum albescentis* Klem. *G. Follmann*, March 1980 (CANL 77635). Follmann: Lich. Exs. Sel. No. 345.

Glyphis achariana Tuck., Amer. J. Sci. Arts, ser. 2, 25: 429 (1858).
ISOSYNTYPE. United States: South Carolina, Santee Canal. *H.W. Ravenel*, 4 February 1858 (CANL 68731). Reliq. Tuck. No. 45.

Gonohymenia cribellifera ssp. **macrocarpa** Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 6 (1990).
ISOTYPE. Canary Islands: Fuerteventura, Sukkulentenhalbwüste auf basisch-kristallinem Gestein, Passstrasse zwischen Betancuria und Pájara nahe Vega del Río de las Palmas; auf sonnenexponierten Sickerwasserflächen bei 550-580 m. *A. Henssen 30731a*, 31.1/1.2. 1986 (CANL 102543). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 37.

Gonohymenia lusitanica Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 7 (1990).
ISOTYPE. Portugal: Baixo-Alentejo, Garique der Serra da Arrabida; auf Sickkerwasserstreifen und in Mulden auf S exponierten Kalkfelsen in Meeresnähe. *A. Henssen & D. Schäfer 21775g*, 9 August 1971 (CANL 102545). Henssen: Lich. Cyanoph Fungi Sax. Exs. No. 39.

Gonohymenia undulata Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 5 (1990).
ISOTYPE. Canary Islands: Fuerteventura, Sukkulentenhalbwüste auf basisch-kristallinem Gestein, Passstrasse zwischen Betancuria und Pájara nahe Vega del Río de las Palmas; auf sonnenexponierten Sickerwasserflächen bei 550-580 m. *A. Henssen 30736b*, 31.1/1.2.1986 (CANL 102540). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 35.
PARATYPE. Canary Islands. *A. Henssen 32048a* (CANL 102541).

Graphina aibonitensis Fink, Mycologia 19: 215 (1927).
ISOTYPE. Puerto Rico: Aibonito. In open woods on bark. *B. Fink 2017*, 1 July 1916 (CANL 2085).

Graphina muscicola Kalb, Kalb: Lich. Neotr. Fasc. 10: 8 (1988).
ISOTYPE. Ecuador: Napo, Bei Sarayacu, zwischen Tena und Baeza. Ad einem feuchten Erdanriss, über Moosen. *K. & A. Kalb*, 10.9.1987 (CANL 102711). Kalb: Lich. Neotr. No. 422.

Graphis subvirginalis Nyl., Bull. Torrey Bot. Club 16: 106 (1889).
ISOTYPE. United States: Florida, Fort George. On *Ilex*. *W.W. Calkins*, 1888 (CANL 2094).

= Graphina subvirginalis (Nyl.) Müll. Arg.

Gyalectidium colchicum Vězda, Folia Geobot. Phytotax., Praha 18: 58 (1983).
ISOTYPE. Russia: Colchis (Transcaucasia occid.) distr. Lazarevskoje: in faucibus rivi Dagomys Zapadnyi, supra vicum Treja Rota. Ad folia *Buxi colchicae*. *A. Vězda*, 25 June 1979 (CANL 85979). Vězda: Lich. Sel. Exs. No. 1866.

Gyalideopsis alnicola Noble & Vězda, Folia Geobot. Phytotax., Bohemoslov. 14: 62 (1979).
ISOTYPES. Canada: British Columbia, Saltspring Island, road to Mount Maxwell. On *Alnus rubra*. *W.J. Noble 5811A*, 3 (30 in protologue) June 1976 (CANL 75390 & 75391).

Gyalideopsis kalbii Vězda, Mitt. Bot. Staatssamml. München 19: 153 (1983).
ISOTYPES. Brazil: São Paulo, Ilha de São Sebastião, etwa 130 km östlich von São Paulo. Osthang des Morro das Tacas; über Moosen, an einem Wegabstich. *K. Kalb* & *J. Poelt*, 7 July 1979 (CANL 89171 & 89439). Vězda: Lich. Sel. Exs. No. 1965; Kalb: Lich. Neotr. No. 323.

Gyalideopsis trapperi Kalb & Vězda, Biblioth. Lichenol. 29: 49 (1988).
ISOTYPE. Ecuador: Napo, Bei Sarayacu, zwischen Tena und Baeza. Als Erstbesiedler auf herumliegenden Urgesteinsblöcken. *K.* & *A. Kalb*, 10.9.1987. (CANL 102712). Kalb: Lich. Neotr. No. 423.

Gyalideopsis vezdae Kalb, Kalb: Lich. Neotr. Fasc. 6: 10 (1983).
ISOTYPE. Brazil: Mato Grosso, Serra dos Coroados, Buriti, Naturschutzgebiet der evangelischen Schule von Buriti, etwa 6 km südwestlich von Buriti. In einem submontanen Regenwald. *K. Kalb*, 8 July 1980 (CANL 84778). Kalb: Lich. Neotr. No. 229.

Gyrophoropsis dwaliensis Räsänen, Arch. Soc. Zool.-Bot. Fenn. "Vanamo" 6: 80 (1952).
ISOTYPE. India: N. W. Himalaya, Dwali, Almora District. 8500 ft. *D.D. & A.M. Awasthi*, 21 May 1950 (CANL 10771).
= Umbilicaria badia Frey

Haematomma inexpectatum Kalb, Kalb: Lich. Neotr. Fasc. 12: 11 (1991).
ISOTYPE. Mexico: Baja California Sur. Along Rte 22; 16 km W of Ciudad Constituión, Southern Magdalena Region of the Socnoran Desert, sandy coastal plain. On bark of deciduous trees. *K.* & *A. Kalb* & *T. Nash*, 1 January 1991 (CANL 103777). Kalb: Lich. Neotr. No. 506.

Haematomma pustulatum Brodo & Culb., Bryologist 89: 203 (1986).
ISOTYPE. United States: North Carolina, Orange Co., Hillsborough, Duke Forest (Quarry Division); near the quarry.

On *Acer rubrum*. *W.L. Culberson & C.F. Culberson 19701*, 22 November 1984 (CANL 96379). Vězda: Lich. Sel. Exs. No. 2152.

Hafellia fosteri Imsh. & Sheard, Bryologist 95: 85 (1992).
PARATYPE. Canada: British Columbia, Discovery Island, 3 km east of Oak Bay, Victoria. On driftwood. *A.M. Crossley & W.J. Noble 5335a*, 3 August 1975 (CANL 102584).

Heppia uruguayensis Räsänen, Arch. Soc. Zool.-Bot. Fenn. "Vanamo" 2: 48 (1947).
HOLOTYPE. Uruguay: Dept. Paysandú. On rocky banks of river Queguay near Paysandú. *I.M. Lamb 3107*, 10 March 1946 (CANL 983).
= Thelidium umbilicatum Th. Fr.

Heterodermia desertorum Kalb, Kalb: Lich. Neotr. Fasc. 8: 10 (1984).
ISOTYPE. Peru: Lima, Küstenwüste bei Huacho, etwa 150 km nördlich von Lima. An kleinen Felsbrocken in der Nebelzone. *K. Kalb & G. Plöbst*, 28 July 1979 (CANL 89440). Kalb: Lich. Neotr. No. 324.

Heterodermia sitchensis Goward & Noble ex Goward, Bryologist 87: 366 (1984).
ISOTYPE. Canada: British Columbia, Vancouver Island, 12 km SE of Tofino, Schooner Cove. On twigs of *Picea sitchensis*. *T. Goward, Kirkvold & McGrenere 83-326*, 30 March 1983 (CANL 95990).

Heterothecium pachycheilum Tuck., Synops. N. Amer. Lich. 2: 56 (1888).
ISOSYNTYPE. United States: South Carolina, Santee Canal. *H.W. Ravenel*, 1857 (CANL 68775). Reliq. Tuck. No. 106.
= Megalospora pachycheila (Tuck.) Sipman

Homothecium sorediosum Henssen, Bot. Not. 132: 271 (1979).
ISOTYPE. Chile: Malleco, Parque Nacional de Contulmo, Südbuchenwald mit *Nothofagus obliqua*; auf Erde und brüchigem Sandstein einer Wegböschung. *A. Henssen, G. Vobis & J. Redón 24271*, 22 February 1973 (CANL 102536). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 31.

Hubbsia lumbricoides W. Weber, Svensk Bot. Tidskr. 59: 61 (1965).
ISOTYPE. Mexico: Baja California, Isla Guadalupe. On seaward-facing basalt cliffs at Melpomene Cove, southernmost tip of the island. *W.A. Weber & C.J. McCoy*, 21 April 1963 (CANL 20874). Weber: Lich. Exs. Colo. No. 85.
= H. californica (Räsänen) W. Beber

Huilia circumnigrata Vězda, Folia Geobot. Phytotax. Praha 14: 205 (1979).
ISOTYPE. Jugoslavia: Montenegro, Sinus Kotor dictus, supra pagum Morin. Ad saxa quartzitica. *A. Vězda*, 18 July 1975 (CANL 73828). Vězda: Lich. Sel. Exs. No. 1665.

Hydrothyria venosa J. Russell, Proc. Essex Inst. 1: 188 (1853).
ISOSYNTYPE. United States: Vermont, Brattleboro. In rivulets from Wantasquit Mt. *J.L. Russell*, 16 July 1851 (CANL 23259). Reliq. Tuck. No. 51.

Hyperphyscia mobergii Kalb, Kalb: Lich. Neotr. Fasc. 11: 9 (1990).
ISOTYPE. Venezuela: Falcon, Distr. Acosta, Zwischen Boca da Tocuyo und San Lorenzo, etwa 20 km NW von Chichiriviche. *K. & A. Kalb*, 24 August 1989 (CANL 102751). Kalb: Lich. Neotr. No. 463.

Hypocenomyce leucococca R. Sant. in Moberg, Publ. Herb. Univ. Uppsala, Thunbergia 2: 3 (1986).
ISOTYPE. Sweden: Härjedalen Prov., Tännäs par., c. 1 km E of Ramundbergets Fjällgård. On the trunk of a birch. *R. Santesson 27901*, 5 August 1977 (CANL 95082). Moberg: Lich. Sel. Exs. Ups. No. 6.

Hypogymnia heterophylla Pike, Mycotaxon 16: 157 (1982).
ISOTYPE. United States: California, Mendocino Co., Pygmy Forest Reserve, Van Damme State Park. On stunted conifers. *M.E. Hale 49365*, 9 June 1977 (CANL 91360). Hale: Lich. Amer. Exs. No. 237.

Hypogymnia hokkaidensis Kurok., Mem. Natl. Sci. Mus. (Tokyo) 4: 62 (1971).
ISOTYPE. Japan: Hokkaido, Prov. Nemuro, Ochiishi. On trunk of *Picea glehnii*. *S. Kurokawa 65826*, 2 September 1965 (CANL 45315). Kurokawa: Lich. Rar. Crit. Exs. No. 167.

Hypogymnia kiboensis Dodge, Ann. Missouri Bot. Gard. 46: 50 (1959).
ISONEOTYPE. Tanzania: Kilimanjaro, above Peter's Hut. In the upper part of the Philippia region, on "frost-lifted ground". *O. Hedberg 1354*, 23 June 1948 (CANL 99605). Moberg: Lich. Sel. Exs. Ups. No. 75.
= Xanthoparmelia kiboensis (Dodge) Krog & Swinscow

Hypogymnia mollis Pike & Hale, Mycotaxon 16: 161 (1982).
ISOTYPE. United States: California, San Luis Obispo Co., Los Osos Oak Reserve, near Los Osos. On low shrubs in sandy area. *M.E. Hale 57768*, 31 July 1980 (CANL 91361). Hale: Lich. Amer. Exs. No 238.

Hypogymnia oceanica Goward, Bryologist 91: 229 (1988).
HOLOTYPE. Canada: British Columbia, Vancouver Island, 5 km SW of Sutton Pass. Trunk and branches of *Pinus contorta*. *T. Goward 83-302*, 20 March 1983 (CANL 87115).
PARATYPE. Canada: British Columbia. *I. M. Brodo 18066*. (CANL 69916).

Involucrothele ligurica Servít, Webbia 10: 443 (1954).
ISOTYPE. Italy: Liguria occid., Spotorno (Savona), Loco Lajolo. Maceriicola. *Sbarbaro*, March 1948 (CANL 985).

Ionaspis ventosa P. Jørg. & R. Sant., Nord. J. Bot. 9: 433 (1989).
ISOTYPE. Sweden: Härjedalen Prov., Tännäs par., Mt. Röstvålen (c. 5 km W of Mt. Stora Mittåkläppen). On pebbles at top of the mountain. *R. Santesson 32679*, 14 August 1989 (CANL 102824). Moberg: Lich. Sel. Exs. Ups. No. 85.

Jenmania osorioi Henssen, Lichenologist 5: 447 (1973).
ISOTYPE. Uruguay: Salto, Uruguay River, Salto Grande Island. Auf dem oberen Teil eines grossen Steins unterhalb der Hochwasserlinie. *H. Osorio 6675*, 4-6 February 1974 (CANL 102583). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 29.

Kalbiana brasiliensis Henssen, Kalb: Lich. Neotr. Fasc. 10: 9 (1988).
ISOTYPE. Brazil: Bahia, Chapada Diamantina, Serra do Tombador, etwa 1 km vor der Stadt Morro de Chapeú. Am Rand von natürlichen, kleinen Wasserbecken, an Sandstein. *K. Kalb*, 20 July 1980 (CANL 102715). Kalb: Lich. Neotr. No. 426.

Lecanactis premnea var. **chloroconia** Tuck., Gen. Lich. p. 194 (1872).
ISOSYNTYPE. United States: New Hampshire, Mt. Washington. *E. Tuckerman*, September 1848 (CANL 68776). Reliq. Tuck. No. 107. = L. chloroconia Tuck.

Lecanactis subdryophila Follm. & Vězda, Philippia 3: 271 (1977).
ISOTYPE. Chile: Prov. Aconcagua. Kieternpflanzung im Windschatten der Isla Seca in der Bucht von Zapallar. *G. Follmann*, January 1965 (CANL 67506). Follmann: Lich. Exs. Sel. No. 247.

Lecania constricta W. Weber, Weber: Lich. Exs. Colo. Fasc. 16: 3 (1984).
ISOTYPE. United States: Colorado, Boulder Co., Outer foothills of the Front Range, "The Flatirons", on southwest edge of City of Boulder. On bark of *Populus angustifolia* just S of mouth of Gregory Canyon. *W.A. Weber, J.W. Sheard* & *R.A. Anderson*, 5 September 1981 (CANL 88658). Weber: Lich. Exs. Colo. No. 614.

Lecania macrocarpa B. de Lesd., Bull. Soc. Bot. France 99: 146 (1952).
ISOTYPE. Italy: Gorzegno, Le Langhe (Piemonte). *Sbarbaro 319*, September 1951 (CANL 12830).

Lecania sbarbaronis B. de Lesd., Bull. Soc. Bot. France 97: 170 (1950).
ISOTYPE. Italy: Varazze per Invrea. Maceriicola in via publica. *Sbarbaro*, June 1949 (CANL 12836).

Lecanora aeruginascens H. Magn., Medd. Göteb. Bot. Trädg. 18: 216 (1950).
ISOTYPE. Uruguay: Montevideo, Carrasco, Cañada de las Cantberas. Sobre rocas expuestas al sol. *H. Osorio*, 17

January 1948 (CANL 11644).

Lecanora austrooceanica Hertel & Leuck., Hertel: Lecideaceae Exs. Fasc. 12: 2 (1990).
ISOTYPE. New Zealand: Southland. Bluff, S of Ocean Beach. Coastal rocks. *H. Hertel 30808*, 12 November 1985 (CANL 102505). Hertel: Lecideaceae Exs. No. 224.

Lecanora bolanderi Tuck., Proc. Amer. Acad. Arts 6: 266 (1864).
LECTOPARATYPE. United States: California, Marin County. *H.N. Bolander* (CANL 68831).
= Cladidium bolanderi (Tuck.) Ryan

Lecanora caesiorubella subsp. **merrillii** Imsh. & Brodo, Nova Hedwigia 12: 28 (1966).
ISOTYPE. United States: California, Berkeley. *M.A. Howe*, February 1893 (CANL 19545). Cummings: Dec. N. Amer. Lich. No. 133.

Lecanora caesiosora Poelt, Denkschr. Regensb. Bot. Ges 26: 82 (1966).
(see Lecanora soralifera H. Magn.).

Lecanora californica Brodo, Beih. Nova Hedwigia 79: 107 (1984).
HOLOTYPE. United States: California, San Mateo Co. Rocks near the sea. *M.A. Howe*, February 1893 (CANL 19543). Cummings: Dec. N. Amer. Lich. No. 131.
PARATYPES. United States: California. *I.M. Brodo 20455* (CANL 76211); Oregon. *I.M. Brodo* (CANL 77027).

Lecanora christoi W. Weber, Bryologist 78: 206 (1975).
ISOTYPE. United States: Colorado, Garfield Co. 8 km N of Rifle. Sandstone ridge on west side of Rifle Creek along south edge of Grand Hogback 3.2 km SW of Rifle Gap. On talus blocks. *W.A. Weber, G. Kunkel & J. Munger*, 12 June 1974 (CANL 52208). Weber: Lich. Exs. Colo. No. 458.

Lecanora cinereofusca var. **appalachensis** Brodo, Beih. Nova Hedwigia 79: 116 (1984).
HOLOTYPE. United States: Arkansas, Newton Co., Lost Valley State Park, 22 miles SW of Harrison. On sandstone block at edge of brook. *I.M. Brodo 23512*, 11 August 1979 (CANL 76592).
PARATYPE. Canada: Nova Scotia. *J. Macoun* (CANL 11825).

Lecanora concinna ("concinnum") Thomson, Bryologist 75: 358 (1972).
ISOTYPE. United States: Alaska, north end at Franklin Bluffs on the Sagavanirktok River. On smooth boulders on gravel bench. *J.W. Thomson, S. Shushan & J. Koranda*, 1958 (CANL 44988). Thomson: Lich. Arct. No. 95.
= a species of Aspicilia

Lecanora congesta Clauz. & Vězda, Portugaliae Acta Biol., Ser. B, 9: 331 (1969).

PARATYPE. France: Gallia, Bouches-du-Rhône, Marseille, insula Maire. Ad saxa calcarea maritima, in septentrionem spectantia. *G. Clauzade*, June 1968 (CANL 55614). Vězda: Lich. Sel. Exs. No. 779.

Lecanora freyi Poelt, Mitt. Bot. Staatssamml. München 2: 464 (1958).
ISOTYPE. Austria: Bregenzer Wald, Ifenstock, Vorarlberg (Kleines Walsertal): Kleiner Gipfel am Hählekopf bei etwa 2000 m, südseitig auf Kieselkalk. *J. Poelt*, July 1958 (CANL 52798). Poelt: Lich. Alpium No. 73.

Lecanora fuliginosa Brodo, Beih. Nova Hedwigia 79: 124 (1984).
HOLOTYPE. Canada: Ontario, Thunder Bay District, Sibley Peninsula, 1.3 miles east of Silver Islet. On exposed rock on bluff. *I.M. Brodo 13735*, 13 June 1968 (CANL 77033).
PARATYPES. Canada: New Brunswick. *S.P. Gowan 3588* (CANL 82233); Ontario. *I.M. Brodo 5941* (CANL 22789), *A. Henssen 14029c* (CANL 77237); Quebec. *I.M. Brodo 18841* (CANL 38740), *E. Lepage 16766* (CANL 34969); Northwest Territories. *J.W. Thomson 12087* (CANL 23472).

Lecanora homalea H. Magn., Medd. Göteb. Bot. Trädg. 18: 217 (1950).
PARATYPE. Uruguay: Montevideo, Carrasco, Cañada de las Canteras. Sobre postes de madera. *H. Osorio 1761*, 17 January 1948 (CANL 12081).

Lecanora imshaugii Brodo, Beih. Nova Hedwigia 79: 137 (1984).
Holotype. Canada: Ontario, Ottawa, Rockcliffe. On a pine trunk. *J. Macoun 345*, 16 April 1896 (CANL 11626).
PARATYPES. Canada: Ontario. *J. Macoun 347* (CANL 12443); United States: Delaware. *I.M. Brodo 9558* (CANL 21882), Virginia. *I.M. Brodo 9435B* (CANL 21780).

Lecanora insolata H. Magn., Kongl. Svenska Vetenskapsakad. Handl. 17: 137 (1939).
ISOTYPE. Sweden: Västergötland, Göteborg, Delsjökärr. On steep, sunny rocks in the heath. *A.H. Magnusson*, 11-10-1937 (CANL 20146). Magnusson: Lich. Sel. Scand. Exs. No. 323.

Lecanora kutakii Senft, Preslia 4: 26 (1926).
ISOTYPE. Czechoslovakia: Sudeti occid., Krkonoše, in valle Obři důl loco dicto Kiesberg. *V. Kuťák*, 1921 (CANL 33384).
= L. gisleri Poelt & Ullrich

Lecanora luteovernalis Brodo, Bryologist 84: 521 (1981).
HOLOTYPE. Canada: Northwest Territories, Dist. of Franklin, Bathurst Island, Polar Bear Pass area. *I.M. Brodo & R.R. Ireland 19435*, 23 July 1973 (CANL 59491).
PARATYPES. Canada: Yukon. *G.W. & G.G. Douglas 8895* (CANL 56763); *G.W. Scotter 19127, 19252, 19257, 19487, 19525, 19530 & 19531* (CANL 50183, 49740, 49739, 54313, 54315, 54316 & 54317); Northwest Territories. *P. Barrett 0807*. (CANL 34299); *G.R. Brassard 4253B* (CANL 28932); *I.M. Brodo 19388* (CANL

53565); *S.D. MacDonald* (CANL 53033); *G.R. Parker SP-70-184C* (CANL 33112); *R.M. Schuster 35941* (CANL 5572); *G.W. Scotter 18487* (CANL 70135); *J.W. Thomson 8689* (CANL 45361).

Lecanora mellea W. Weber, Bryologist 78: 208 (1975).
ISOTYPE. United States: California, Sacramento Co., SE of Sacramento between Slough House and Bridge House. On sloping faces of rock outcrops. *W.A. Weber & S. Kipp*, 24 March 1974 (CANL 52212). Weber: Lich. Exs. Colo. No. 462.

Lecanora microbola Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53. Bull. 132: 291 (1954).
HOLOTYPE. Canada: Nova Scotia, Cape Breton Co., Cape Breton Island, Louisbourg. On large stone near seashore. *I.M. Lamb 6897*, 19 July 1952 (CANL 12151).

Lecanora oleae ("olea") Reich. & Galun, Bull. Res. Council Israel Sect. D, Bot. 6D: 238 (1958).
SYNTYPE. Israel: Thalpioth (Jerusalem). On *Olea europea*. *I. Reichert 8(1)*, 16 October 1933 (CANL 32294).

Lecanora opiniconensis Brodo, Mycotaxon 26: 309 (1986).
HOLOTYPE. Canada: Ontario, Leeds Co., Snake Island in Lake Opinicon. Queen's University Biological Station, Chaffeys Locks. *I.M. Brodo 25117*, 2 February 1985 (CANL 92112).
PARATYPES. Canada: Ontario. *I.M. Brodo 456, 13575B, 20277, 23432B & 23543* (CANL 23295, 79030, 53929, 72543 & 80250); *R.F. Cain 26672* (CANL 44587); *H.L. Dickson 154* (CANL 57666); *C.E. Garton 5467, 6089 & 22268* (CANL 12295, 12304 & 87731); *C.M. Wetmore 28714 & 29679* (CANL 85169 & 85259). Quebec. *I.M. Brodo 21015* (CANL 54173). United States: Maine. *S. Selva 990* (CANL 98807). Michigan. *C.M. Wetmore 47222* (CANL 90696). Minnesota. *C.M. Wetmore 34532 & 35014* (CANL 75807 & 75810). S. Dakota. *C.M. Wetmore 8760* (CANL 12150). Wisconsin. *T.S. & B.A. Cochrane 5601* (CANL 45366).

Lecanora orae-frigidae R. Sant., Lich. Sweden Norway, p.145 (1984).
(see Lecidea sorediata Lynge).

Lecanora pachysoma Ryan & Poelt, Bryologist 92: 518 (1989).
PARATYPES. Mexico. *T.H. Nash 8804.* (CANL 52389); *W.A. Weber & C.J. McCoy.* (CANL 20876). Weber: Lich. Exs. Colo. No. 87.

Lecanora perplexa Brodo, Beih. Nova Hedwigia 79: 148 (1984).
HOLOTYPE. Canada: Quebec, Gatineau Co., Gatineau Park, King Mountain area off Mountain Road, 3 mi. NW of Notch Road intersection. On limestone cliff. *I.M. Brodo 21192*, 6 October 1975 (CANL 67214).
PARATYPES. Canada: Ontario. *I.M. Brodo 6070* (CANL 22769), *A. Henssen 14276* (CANL 77235), *J. Macoun*? (CANL 11624); Quebec. *I.M. Brodo 23585* (CANL 73901); United States: Arkansas. *I.M. Brodo 13504* (CANL 76596).

Lecanora pseudopinguis W. Weber, Mycotaxon 13: 102 (1981).
ISOTYPE. Ecuador: Galápagos Islands, Isla Santa Cruz. On

rocks just above high tide. *W.A. Weber & J. Lanier*, 10 April 1976 (CANL 58215). Weber: Lich. Exs. Colo. No. 500.

Lecanora pycnocarpa H. Magn., Bot. Not. 1939: 310 (1939).
ISOTYPE. Sweden: Uppland, Vallentuna, Åbydal. On *Populus tremula*. *A.H. Magnusson*, 12 June 1934 (CANL 20132). Magnusson: Lich. Sel. Scand. Exs. No. 305.

Lecanora salicicola H. Magn., Bot. Not. 1939: 311 (1939).
ISOTYPE. Sweden: Jämtland, Åre, Skalstugan. On branches of dying *Salix*. *C. Stenholm*, 28 July 1933 (CANL 20133). Magnusson: Lich. Sel. Scand. Exs. No. 306.

Lecanora soralifera H. Magn., Bot. Not. 1937: 135 (1937).
ISOTYPE. Sweden: Västergötland, Partille, northwest of Tultered. On stone fence. *A.H. Magnusson*, 27 August 1936 (CANL 20111). Magnusson: Lich. Sel. Scand. Exs. No. 270.
≡ L. caesiosora Poelt

Lecanora superfluens H. Magn., Acta Horti Gothob. 19: 46 (1952).
ISOTYPE. Canada: Northwest Territories, Baffin Island. Head of Clyde Fiord. On wet soil near large boulders. *M.E. Hale 416*, 26 June 1950 (CANL 12472).
= L. geophila (Th. Fr.) Poelt

Lecanora texana W. Weber, Mycotaxon 13: 103 (1981).
ISOTYPE. United States: Texas, Gillespie Co. (not "Llano Co. as given on the label), Texas Hill Country, trail to Balanced Rock, 6.4 km N of Fredericksberg. On vertical N-facing of large blocks. *W.A. Weber*, 29 April 1974 (CANL 52201). Weber: Lich. Exs. Colo. No. 451.

Lecanora thallophila H. Magn., Bot. Not. 107: 196 (1954).
ISOTYPE. United States: Utah, San Juan Co., Devil's Canyon. On *Dermatocarpon miniatum* on dry exposed sandstone. *S. Flowers 476*, 21 June 1952 (CANL 71524).

Lecanora utahensis H. Magn., Acta Horti Gothob. 19: 39 (1952).
ISOTYPE. United States: Utah, Wayne Co., Ekker's Ranch. On dry exposed sandstone. *S. Flowers 3107*, 20 May 1951 (CANL 12503).

Lecanora weberi Ryan, Mycotaxon 36: 10 (1989).
ISOTYPE. United States: Colorado, Boulder Co., Boulder Mountain Parks, just S of city of Boulder. On scattered low fine-grained sandstone or quartzite boulders. *W.A. Weber*, 10 August 1986 (CANL 97984). Weber: Lich. Colo. Exs. No. 685.

Lecidea baffiniana H. Magn., Acta Horti Gothob. 19: 43 (1952).
ISOTYPE. Canada: Northwest Territories, Baffin Island, Cape Searle. On phonolite at the bird cliffs. *M.E. Hale 391*, 17-18 August 1950 (CANL 4786).

Lecidea carbonoidea Thomson, Bryologist 75: 356 (1972).
ISOTYPE. United States: Northern Alaska, along the Pitmegea River, 15 miles upstream from Cape Sabine. On top of ridge. *J.W. Thomson*, 10-17 July 1958 (CANL 44987). Thomson: Lich. Arct. No. 94.
= Immersaria carbonoidea (Thomson) Esnault & Roux

Lecidea grassiana H. Magn., Medd. Göteborgs Bot. Trädg. 17: 60 (1947).
ISOTYPE. Argentina: Prov. Salta, Quebrada de San Lorenzo. *M. Digilio-Grassi 336*, 1946 (CANL 5061).

Lecidea gypsicola Llimona, Vězda: Lich. Sel. Exs. Fasc. 47: 3 (1973).
ISOTYPE. Spain: Las Bárdenas, Caparosso. Ad gypsum compactum locis septentr. vel occident. spectantibus. *X. Llimona*, 24 September 1972 (CANL 77198). Hertel: Lecideaceae Exs. No. 45.

Lecidea (Psora) hyotheja Lamb, Farlowia 4: 444 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Verde near Futalaufquen, On soil in crevices of an almost vertical rock on the shore of the lake. *I.M. Lamb 5870*, 1 February 1950 (CANL 5072).
PARATYPE. Argentina: Lago Cisnes. *I.M. Lamb 5932* (CANL 5071).

Lecidea leproloma R. Sant., Lich. Sel. Exs. Upsal., Thunbergia 2: 6 (1986).
ISOTYPE. Sweden: Härjedalen Prov., Tännäs par., Mt Gruvvålen, 0.2 km SSW of Lake Glimsjön (c. 1.8 km NE of Ramundbergets Fjällgård). On a vertical rock wall. *R. Santesson 31390*, 19 August 1985 (CANL 95090). Moberg: Lich. Sel. Exs. Ups. No. 14.

Lecidea patagonica Lamb, Farlowia 4: 440 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Pathway from Lago Frías to the Frías Glacier. On a stone beside the path in the forest. *I.M. Lamb 6029*, 13 November 1950. (CANL 5290).
PARATYPE. Argentina: Lake Nahuel Huapi. *I.M. Lamb 5818* (CANL 5289).

Lecidea santensis Tuck., Amer J. Sci. Arts ser. 2, 25: 428 (1858).
SYNTYPE. United States: South Carolina. *H.W. Ravenel* (CANL 23244). Reliq. Tuck. No. 15.
= Phyllopsora corallina (Eschw.) Müll. Arg.

Lecidea shushanii Thomson, Bryologist 75: 356 (1972).
ISOTYPE. United States: Northern Alaska, valley of the Okpilak River at Okpilak Lake near Mt. Michelson. On huge boulder at top of ridge. *J.W. Thomson & S. Shushan 9316*, 3 August 1958 (CANL 44982).

Lecidea sorediata Lynge, Novaya Zemlya 43: 117 (1928).
ISOLECTOTYPE. Russia: Novaya Zemlya, Nordre Kristovii holmen. *B. Lynge*, 14 August 1921. (CANL 5430).
≡ Lecanora orae-frigidae R. Sant.

Lecidea ullrichii Hertel, Hertel: Lecideaceae Exs. Fasc. 10: 4 (1988).
ISOTYPE. Germany: Niedersachsen, Harz Ramelsberg bei Goslar. *H. Ullrich*, 26 October 1982 (CANL 96965). Hertel: Lecideaceae Exs. No. 190.

Lempholemma dispansum H. Magn., Bot. Not. 1939: 302 (1939).
ISOTYPE. Sweden: Dalsland, Bäcke, Kårud. On sunny, slightly irrigated, calcareous rock. *S. Bergström* & *A.H. Magnusson*, 24 June 1938 (CANL 20128). Magnusson: Lich. Sel. Scand. Exs. No. 298.

Leproloma diffusum var. **chrysodetoides** Laundon, Lichenologist 21: 18 (1989).
ISOTYPE. Sweden: Värmland Prov., Burtjärn par., on the western slope of the hill between Irettondetjärnen and Svarttjärnen. Over mosses on perpendicular rock. *L.E. Muhr 598*, 8 November 1977 (CANL 99591). Moberg: Lich. Sel. Exs. Ups. No. 61.

Leptogium caesiellum Tuck., Synopsis N. Amer. Lich. 1: 156 (1882).
ISOTYPE. United States: Illinois, Athens. *E. Hall*, 1876 (CANL 23261). Reliq. Tuck. No 53.
= L. byssinum (Hoffm.) Zwackh ex Nyl.

Letharia togashii Asah., J. Jap. Bot. 27: 295 (1952).
ISOTYPE. Japan: Honshu. Prov. Kai, Oshino-mura, Minami-Tsuru-gun. On twigs of *Picea polita*. *M. Togashi*, 11 August 1952 (CANL 26404). Kurokawa: Lich. Rar. Crit. Exs. No. 66.

Letharia wandelensis Hue, Expedit. Antarct. Franç. 1903-1905, p. 6 (1908).
ISOTYPE. Antarctica: Graham Land (Palmer Peninsula), Booth (Wandel) Island. *Expedit. Antarct. Franç. 1903-1905, No. 277* & *299* (CANL 16959).

Lichen candelarius L., Spec. Plant 2: 1141, 1753.
ISONEOTYPE. Sweden: Öland Prov., Böda par., Mensalvaret. On the top of granitic boulders. *R. Santesson* & *T. Tønsberg 30905*, 3 August 1983 (CANL 95101). Moberg: Lich. Sel. Exs. Ups. No 25.
= Xanthoria candelaria (L.) Th. Fr.

Lichen salazinus Bory, Voyage Quatre Iles d'Afrique 3: 106 (1804).
ISOLECTOTYPE. Africa: Réunion (Bourbon) Island. *Bory de St. Vincent* (CANL 75659).
= Stereocaulon salazinum (Bory) Fée

Lichenoconium parasiticum D. Hawksw., Persoonia 9: 178 (1977).
ISOTYPE. Denia: Sjaellandia, Herstedvester. In apotheciis *Lecanorae conizaeoidis*. *M.S. Christiansen 11707*, 20 April (July in protologue) 1944 (CANL 69519). Vězda: Lich. Sel. Exs. No. 1600.

Lichenostigma maureri Hafellner, Herzogia 6 : 299 (1982).
PARATYPE. Italy: Südtirol, Mendelgebirge SW von Bozen, Mte. Roën, Lärchen-Fichtenwald auf der N-Seite. *J. Hafellner*, October 1976 (CANL 91566). Poelt: Pl. Graecenses No. 319.

Lichina macrospora Henssen, Büdel & Wessels, Mycotaxon 22: 171 (1985).
ISOTYPE. South Africa: Ost-Transvaal, Graskop 2430DD, Panorama Falls, Lookout Point. Auf Sandsteinplatten am Rande von Rinnsalen. *A. Henssen & D. Wessels 28405a*, 8 June 1982 (CANL 102537). Henssen: Lich. Cyanoph. Fungi sax. Exs. No. 32.

Lichina polycarpa Henssen, Lichenologist 5: 450 (1973).
PARATYPE. Argentina: Patagonia, Prov. Río Negro, Lake Nahuel Huapí, Isla Victoria. On semi-decomposed rock at side of lake. *I.M. Lamb 5822(=5821)*, 26 January 1950 (CANL 2358).

Lichina rosulans Henssen, Lichenologist 4: 95 (1969).
ISOTYPE. Argentina: Patagonia, Prov. Río Negro, Lake Nahuel Huapí, Isla Victoria. On rocks at shore of lake. *I.M. Lamb 5847(=5857)*, 28 January 1950. (CANL 27353)

Lobaria fulva Hoffm., Deutschl. Flora, p. 159, 1796.
ISONEOTYPE. Germany: Bavaria, Berchtesgadener Land, Unterschönau, Astenreitweg-Zulehenweg. Ad truncum *Aceris pseudoplatani*. *R. Türk & H. Wunder*, 30 April 1991 (CANL 103428). Vězda: Lich. Sel. Exs. No. 2500.
= Xanthoria fulva (Hoff.) Poelt & Petutschnig

Lobaria fuscotomentosa Yoshim., J. Hattori Bot. Lab. 34: 311 (1971).
ISOTYPE. Japan: Honshu, Prov. Echigo. On trail between the summit and Akayu, Mt. Naeba. On trunk of trees. *S. Kurokawa 57194*, 17 August 1957 (CANL 45320). Kurokawa: Lich. Rar. Crit. Exs. No. 172.

Lobaria gyrophorica Yoshim., J. Hattori Bot. Lab. 34: 275 (1971).
ISOTYPE. Taiwan: Prov. Ilan, Piyanan Pass. On trees. *S. Kurokawa 794*, 16 January 1964 (CANL 68480). Kurokawa: Lich. Rar. Crit. Exs. No. 365.

Lobaria tuberculata Yoshim., J. Hattori Bot. Lab. 34: 280 (1971).
ISOTYPE. Japan: Hokkaido, Prov. Nemuro, Ochiishi. On trunk of *Salix* sp. *S. Kurokawa 65767*, 1 September 1965 (CANL 45326). Kurokawa: Lich. Rar. Crit. Exs. No 178.

Maronella laricina M. Steiner, Österr. Bot. Z. 106: 441 (1959).
ISOTYPE. Austria: Wipptal, Tirol, Steinach-Mauern. Fussteil, NW-Flanke von *Larix decidua* an einem Rinnsal in Fettwiesen. *M. Steiner*, August 1958 (CANL 52819). Poelt & Steiner: Lich. Alpium No. 102.

Mazosia pilosa Kalb & Vězda, Folia Geobot. Phytotax., Praha 23: 203 (1988).
ISOTYPES. Brazil: Amazonas, Manaus, in ripa fluminis Rio Negro, 100-200 km supra Manaus. Foliicola in pluviisilva. *K. Kalb*, 14 October 1980 (CANL 97329 & 102720). Vězda: Lich. Sel. Exs. No. 2227; Kalb: Lich. Neotr. No. 431.

Mazosia pseudobambusae Kalb & Vězda, Folia Geobot. Phytotax., Praha 23: 207 (1988).
ISOTYPE. Brazil: São Paulo, Ilha de São Sebastiao, 130 km ad orientem a São Paulo. Folliicola in pluviisilva. *K. Kalb, J. Poelt & H. Sipman*, 6 July 1980 (CANL 97330). Vězda: Lich. Sel. Exs. No. 2228.

Megalospora foersteri Kalb, Kalb: Lich. Neotr. Fasc. 11: 10 (1990).
ISOTYPE. Venezuela: Merida, Distr. Libertador, Pico Espejo, SE von Mérida, Loma Redonda. Über feuchten Moosen auf Lichtungen eines kleinen Restwäldchens. *K. & A. Kalb*, 10 August 1989 (CANL 102753). Kalb: Lich. Neotr. No. 465.

Melanaria macounii Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53. Bull. 1323: 286 (1954).
HOLOTYPE. Canada: Nova Scotia, Victoria Co., Cape Breton Island, Franey Mountain trail near Ingonish. On trunk of *Fagus*. *I.M. Lamb 6985*, 6 August 1952 (CANL 11613).
= Pertusaria macounii (Lamb) Dibben

Melanaria macounii var. **meizotoca** Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53. Bull. 132: 287 (1954).
HOLOTYPE. Canada: Nova Scotia, Cape Breton Island, Baddeck. *J. Macoun 1953, p.p.*, 9 July 1898 (CANL 11479).
= Pertusaria macounii (Lamb) Dibben

Melaspilea fuscolimitata Fink, Mycologia 19: 211 (1927).
ISOTYPE. Puerto Rico: Yauco, Dry Hill. On bark. *B. Fink 1480*, 29 December 1915 (CANL 1974).

Micarea muhrii Coppins, Bull. Brit. Mus. (Nat. Hist.), Bot. 11(2): 160 (1983).
ISOTYPE. Sweden: Vermlandia, par. Lungsund, Punbäcken. Loco aperto ad truncum decorticatum supra rivum. *L.E. Muhr 285 (2851* in protologue), 15 July 1980 (CANL 89160). Vězda: Lich. Sel. Exs. No. 1954.
= Micaria vulpinaris (Nyl.) Muhr

Microthelia atramentea Norman, Bot. Not. 1867: 88 (1867).
ISOTYPE. Norway: Finmark, Tanafjord, Lille Lerpollen. *J.M. Norman*, 1866 (CANL 93368).

Muhria urceolata P. Jørg., Notes Roy. Bot. Gard. Edinburgh 44: 583 (1987).
ISOTYPE. Sweden: Värmland. Dalby, Gravbäcken, 6 km N of Sysslebäck. *L.E. Muhr 4208*, 6 August 1981 (CANL 95302).

Mycoglaena quercicola R. Harris, Michigan Bot. 12: 30 (1973).

ISOTYPE. United States: Iowa, Bremer Co., Iowa. *B. Fink*, 1895 (CANL 1266).

Nephroma chubutense Lamb, Farlowia 4: 438 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Chubut, W end of Lago Menéndez in the lower reaches of the Torrecillas stream. On trunk of a small tree. *I.M. Lamb 5916*, 4 February 1950 (CANL 102257).

Nephroma kuehnemannii Lamb, Farlowia 4: 436 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Menéndez, Alerzal del Norte. *O. Kühnemann 5485*, 1941 (CANL 3751).

Nephroma lepidophyllum f. **hypomelaenum ("hypomelaena")** Räsänen, Farlowia 4: 439 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Río Negro, Lago Frías, pathway alongside the Frías stream on trunk of *Nothofagus pumilio*. *I.M. Lamb 6010*, 12 February 1950 (CANL 3785).

Nephroma occultum Wetm., Bryologist 83: 243, !980.
ISOTYPE. United States: Oregon, Lane Co., 7 miles NE of Blue River, H.J. Andrews Experimental Forest, 2 miles NE of the junction of Blue River and Lookout Creek. On old growth *Pseudotsuga menziesii* branches. *S. Sundberg 120*, 19 February 1978 (CANL 75860).

Neuropogon rohmederi Lamb, Lilloa 14: 158 (1948).
ISOTYPE. Argentina: Chubut, Lago Futalaufquén. *G. Rohmeder* (Herb. Crypt. Inst. Lillo no. 2275), 1945. (CANL 17205).
= Usnea perpusilla (Lamb) F. J. Walker

Neuropogon rohmederi f. **ushuaiensis** Lamb, Lilloa 14: 160 (1948).
ISOTYPE. Argentina: Tierra del Fuego, Sierra Alvear, ca. 20 km ENE of Ushuaia. On rocks. R. Santesson 640a p.p., 1940 (CANL 17209).
= Usnea perpusilla (Lamb) F. J. Walker

Neuropogon trachycarpus f. **elatior** Lamb, Lilloa 14: 157 (1948).
ISOTYPE. Argentina: Tierra del Fuego, Sierra Alvear, southern slope, above Las Cotorras (about 20 km ENE of Ushuaia). On rocks in the alpine region. *R. Santesson 640b*, 1940 (CANL 17258).
= Usnea trachycarpa (Stirt.) Müll. Arg.

Ochrolechia gowardii Brodo, Canad. J. Bot. 69: 746 (1991).
HOLOTYPE. Canada: British Columbia, Wells Gray Park, Wavy Mt. near Murtle Lake. On branch of *Abies lasiocarpa*. *T. Goward 86-39-5*, 13 August 1980 (CANL 96072).

Ochrolechia juvenalis Brodo, Canad. J. Bot. 69: 749 (1991).
HOLOTYPE. United States: California, Mendocino Co., Fort Bragg. On twigs of *Pinus muricata*. *I.M. Brodo 25301*, 13 July 1986 (CANL 94666).

Ochrolechia montana Brodo, Canad. J. Bot. 69: 753 (1991).
HOLOTYPE. United States: Montana, Lake Co., near Soup Creek, Swan Range. On bark. *B. McCune 8854*, 26 August 1877 (CANL 77559).

Ochrolechia pseudopallescens Brodo, Canad. J. Bot. 69: 755 (1991).
HOLOTYPE. Canada: Quebec, Gatineau Co., near Eardley in *Picea mariana* bog between Ramsay Lake and Lac Hawley. On *Picea mariana* twigs. *I.M. Brodo 16280*, 2 October 1969 (CANL 34613).

Ochrolechia subisidiata Brodo, Canad. J. Bot. 69: 759 (1991).
HOLOTYPE. United States: Arizona, Gila Co., McFadden Peak, 15 mi. S of Young. On dead *Juniperus* branch. *T.H. Nash 11166* (CANL 58113).

Ochrolechia trochophora var. **pruinirosella** Brodo, Canad. J. Bot. 69: 763 (1991).
PARATYPES. Canada: New Brunswick. *Gowan 3129* (CANL 81779); Ontario. *I.M. Brodo 14680 & 16130* (CANL 27752 & 60142); Quebec, *I.M. Brodo 9630, 16895 & 25290* (CANL 21653, 72040 & 93690); Prince Edward Island. *J. Fabiszewski 7C & 9A* (CANL 93299 & 93300).

Ochrolechia tuckermanii Vers., Beih. Nova Hedwigia 1: 97 (1962).
ISOTYPE. United States: Massachusetts, Manchester. *E. Tuckerman*, 1839. (CANL 23277). Reliq. Tuck. No. 114 ("No. 14" in protologue).
= O. yasudae Vainio

Omphalodina bullata Follm. & Crespo, Philippia 3: 24 (1976).
ISOTYPE. Spain: Prov. Toledo, Koloniebildend an halbschattigen, luftfeuchten, teils überhängenden, verhältnismässig glatten Silikatfeisen. *G. Follmann & A. Crespo*, 1975. (CANL 58316). Follmann: Lich. Exs. Sel. No. 174.
= Rhizoplaca bullata (Follm. & Crespo) Leuck. & Poelt.

Opegrapha albidoatra Fink, Mycologia 19: 210 (1927).
PARATYPE. Puerto Rico: Naranjito. In woods on bark. *B. Fink 298*, 27 November 1915 (CANL 1903).

Opegrapha astraea Tuck., Lich. Calif. p. 33 (1866).
SYNTYPES. United States: South Carolina, Santee Canal. On *Acer rubrum. H.W. Ravenel 466, 472* (CANL 68781, 68782). Reliq. Tuck. Nos. 119a, 119b.

Opegrapha pertusariicola Coppins & P. James, Lichenologist 11: 164 (1979).
ISOTYPE. Great Britain (England): Caledonia, Mid-Perthshire, Aberfeldy, Glen Lyon, prope Woodend. In thallo *Pertusariae leucoplacae* vigens, ad corticem *Coryli. P. James & B.J. Coppins 3834*, 11 September 1976 (CANL 73861). Vězda: Lich. Sel. Exs. No. 1699.

Opegrapha subabnormis Fink, Mycologia 19: 210 (1927).
ISOTYPE. Puerto Rico: Mayaguez. In open field on bark. *B. Fink 1245*, 33 December 1915 (CANL 1946).

Oropogon colibor Essl., Syst. Bot. Monogr. 28: 60 (1989).
ISOTYPE. Costa Rica: Cartago Prov., about 20.4 km SE of El Palme. On tree bark. *F. Almeda 2143B*, 27 December 1973 (CANL 98282).

Oropogon diffractaicus Essl., Syst. Bot. Monogr. 28: 61 (1989).
ISOTYPE. West Indies: Dominican Republic, Sierra de la Pelonia, Maciso Central, Cordillera Central. On small shrub in open. *C.M. Wetmore & H.A. Imshaug 3652*, 9 August 1958 (CANL 16620).

Oropogon mexicanus Essl., Syst. Bot. Monogr. 28: 92 (1989).
ISOTYPE. Mexico: State of Oaxaca, Trail leading to Cerro San Felipe. On conifers. *M.E. Hale 20706*, 1 April 1960 (CANL 31064).

Pannaria leucostictoides Ohlsson, Bryologist 76: 379 (1973).
ISOTYPE. Canada: British Columbia, Queen Charlotte Islands, Moresby Island, Skidegate Lake. *On branches of Malus. I.M. Brodo 11085*, 9 July 1967 (CANL 29174).

Parmelia alabamensis Hale & McCull., Bryologist 71: 44 (1968).
ISOTYPE. United States: Alabama, St. Clair Co., 6 miles E of Leeds. On sandstone outcrops. *M.E. Hale 24072*, June 1966 (CANL 31055).
= Paraparmelia alabamensis (Hale & McCull.) Elix & Johnston

Parmelia albertana Ahti, Bryologist 72: 236 (1969).
ISOTYPE. Canada: Alberta, near SW tip of Big Lake, ca. 10 mi. NW of Edmonton City. On *Populus balsamifera. T. Ahti 23128*, 7 July 1967 (CANL 28560).
= Melanelia albertana (Ahti) Essl.

Parmelia ambigua var. **halei** Tuck., Synops. N. Amer. Lich. 1: 66 (1882).
ISOSYNTYPE. United States: South Carolina. On *Pinus mitis. H.W. Ravenel* (CANL 68744). Reliq. Tuck. No. 65.
= Parmeliopsis subambigua Gyelnik

Parmelia chlorochroa Tuck., Proc. Amer. Acad. Arts 4: 383 (1860).
ISOSYNTYPE. United States: North Dakota, Missouri River. *F.V. Hayden*, 1859-60 (CANL 68784). Reliq. Tuck. No. 121.
= Xanthoparmelia chlorochroa (Tuck.) Hale

Parmelia crinita f. **varians** G. K. Merrill, Bryologist 11: 95 (1908).
HOLOTYPE. Canada: Ontario, Carleton Place. On elm trees in a swamp. *J. Macoun 3828*, 12 May 1900 (CANL 13348).
= Parmotrema subtinctorium (Zahlbr.) Hale

Parmelia cryptoxanthoides Kurok., Bull. Natl. Sci. Mus. Tokyo. 17: 297 (1974).
ISOTYPE. Brazil: Paraná, Jardim Paraizo, 9 km west of Curitiba. On trees. *S. Kurokawa 8245*, 9 July 1971 (CANL 57029). Kurokawa: Lich. Rar. Crit. Exs. No. 232.

Parmelia elabens Kurok., Bull. Natl. Sci. Mus. Tokyo. 17: 298 (1974).
ISOTYPE. Brazil: Paraná, Jardim Paraizo, 9 km west of Curitiba. On trees. *S. Kurokawa 8253*, 9 July 1971 (CANL 57030). Kurokawa: Lich. Rar. Crit. Exs. No. 233.

Parmelia dubia var. **scrobiculata** B. de Lesd., Bull. Soc. Bot. France 99: 145 (1952).
ISOTYPE. Italy: Liguria sabatia, Spotorno, tinicola loco "Collina". *Sbarbaro*, 19 December 1951 (CANL 13700).
= Punctelia perreticulata (Räsänen) Wilhelm & Ladd

Parmelia frondifera G. K. Merrill, Bryologist 11: 91 (1908).
HOLOTYPE. Canada: Ontario, Essex Co., Point Pelee. On cedar bark. *J. Macoun 3627*, 27 May 1901 (CANL 13193).
= Punctelia bolliana (Müll. Arg.) Krog

Parmelia hygrophila Goward & Ahti, Ann. Bot. Fenn. 20: 9 (1983).
ISOTYPE. Canada: British Columbia, Kokanee Creek Provincial Park, 17 km east of Nelson. On trunk of *Betula papyrifera*. *T. Goward 81-1601*, 25 July 1981 (CANL 86317).

Parmelia gloriosa Kurok., Stud. Cryptog. Papua New Guinea p. 135 (1979).
ISOTYPE. Papua New Guinea: Central District, Mt. Albert Adward, around Abios Hut. On bark of *Pandanus* sp. *S. Kurokawa 9113*, 31 October 1975 (CANL 68483). Kurokawa: Lich. Rar. Crit. Exs. No. 368.

Parmelia omphalodes subsp. **glacialis** Skult, Ann. Bot. Fenn. 22: 201 (1985).
HOLOTYPE. Canada: Northwest Territories, Dist. of Franklin, Prince Patrick Island, Mould Bay. On damp polygon soil. *S.D. MacDonald*, 24 July 1952 (CANL 13656).
PARATYPES. Canada: Northwest Territories. *L. C. Bliss 2.* (CANL 70510); *M. Kuc 6, AA-14, AK-11, AK-12, AK-13, AM-24, AN-15, LC-13* & *LD-11* (CANL 29811, 29854, 29871, 29818, 29787, 29850, 29840, 29774 & 29779); *S.D. MacDonald* (CANL 13647); *D.B.O. Savile 4102* (CANL 46004); *D.W. Smith* (CANL 63481).
= Parmelia skultii Hale

Parmelia pacifica Kurok., Mem. Natl. Sci. Mus. Tokyo 11: 28 (1978).
ISOTYPE. Japan: Bonin Islands, Hahajima Island, En route between Oki-mura and Cape Minami-zaki. On bark of *Pandanus boninensis*. *S. Kurokawa 77014*, 3 August 1977 (CANL 68485). Kurokawa: Lich. Rar. Crit. Exs. No. 370.

Parmelia physodes var. **enteromorpha** f. **rugosa** G. K. Merrill,

Bryologist 11: 86 (1908).
HOLOTYPE. Canada: British Columbia, near MacLeodes Lake. *J. Macoun 696*, 27 June 1875 (CANL 14331).
= Hypogymnia rugosa (G. K. Merrill) Pike

Parmelia physodes f. **subisidioides** G. K. Merrill, Bryologist 11: 86 (1908).
SYNTYPE. Canada: Alberta. On old logs at Laggan. *J. Macoun 3635*, 26 June 1904 (CANL 14298).
= Hypogymnia austerodes (Nyl.) Räsänen

Parmelia ralla Brusse, Mycotaxon 27: 241 (1986).
ISOTYPE. South Africa: Swartberg range, Seven Weeks poort, 8.6 km NW of Amalienstein. On Table Mountain sandstone boulders. *F. Brusse 4935*, 10 February 1986 (CANL 97358).

Parmelia reptans Kurok., Austral. J. Bot. 21: 137 (1973).
ISOTYPE. Australia: Victoria, 6 miles west of Red Cliffs along the Werrimull Road. On soil. *S. Kurokawa 6621*, 8 December 1965 (CANL 68487). Kurokawa: Lich Rar. Crit. Exs. No. 372.
= Xanthoparmelia reptans (Kurok.) Elix & Johnston

Parmelia saximontana R. Anderson & W. Weber, Bryologist 65: 236 (1962).
ISOTYPE. United States: Colorado, Boulder Co., Dakota Group just NW of Boulder. On sandstone. *R.A. Anderson & W.A. Weber L-30072*, 6 April 1962 (CANL 20831). Weber: Lich. Exs. Colo. No. 41.
= Melanelia tominii (Oxner) Essl.

Parmelia semansiana Culb. & C. Culb., Mycologia 72: 128 (1980).
ISOTYPE. United States: Arkansas, Polk Co., 5 km ad septentriones versus a Mena, in loco dicto Blue Haze Vista prope viam dictam Talimena Skyline Drive. Ad saxa in silva. *W.L. Culberson & C.F. Culberson 16074*, 20 August 1972 (CANL 76386). Vězda: Lich Sel. Exs. No. 1737.
= Punctelia semansiana (Culb. & C. Culb.) Krog

Parmelia spinibarbis Kurok., Bull. Natl. Sci. Mus. Tokyo. 17: 299 (1974).
ISOTYPE. Brazil: Rio de Janeiro, Petrópolis. On trees. *S. Kurokawa 8348*, 17 July 1971 (CANL 57035). Kurokawa: Lich. Rar. Crit. Exs. No. 238.

Parmelia squarrosa Hale, Phytologia 22: 29 (1971).
ISOTYPE. United States: Virginia, Madison Co., Shenandoah National Park. On *Quercus alba*. *M.E. Hale 36949*, 30 April 1979 (CANL 38279). Hale: Lich. Amer. Exs. No. 142.

Parmelia subdistorta Kurok., J. Hattori Bot. Lab. 32: 212 (1969).
ISOTYPE. Australia: Victoria, 6 miles west of Red Cliffs along the Werrimull Road. On soil. *S. Kurokawa 6617*, 8 December 1965 (CANL 45332). Kurokawa: Lich. Rar. Crit. Exs.

No. 184.
= Xanthoparmelia subdistorta (Kurok.) Hale

Parmelia sulcifera Kurok., Bull. Natl. Sci. Mus. Tokyo. Ser. B, 8: 37 (1982).
ISOTYPE. Australia: New South Wales, 9 miles E of Cooma on Numeralla Road. On rocks. *S. Kurokawa 6450*, 2 December 1965 (CANL 87340). Kurokawa: Lich. Rar. Crit. Exs. No. 583.
= Xanthoparmelia sulcifera (Kurok.) Hale

Parmelia trabeculata Ahti, Acta Bot. Fenn. 70: 54 (1966).
PARATYPE. Canada: Ontario, Kenora District, Winisk. On trunks of *Populus balsamifera. T. Ahti 4669*, 7 August 1958 (CANL 14265).
= Melanelia trabeculata (Ahti) Essl.

Parmelia virginica Hale, Contr. U.S. Natl. Herb. 36(4): 186 (1964).
ISOTYPE. United States: Virginia, Page Co., Hawksbill, Shenandoah National Park. On fir trees. *M.E. Hale 21592*, 26 June 1962 (CANL 31054).
= Hypotrachyna virginica (Hale) Hale

Parmeliella concinna Lamb, Farlowia 4: 431 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Verde near Futalaufquén. On a carbonised trunk in open forest. *I.M. Lamb 5879*, 1 November 1950 (CANL 2629).

Parmeliella granulata Lamb, Farlowia 4: 429 (1955).
HOLOTYPE. Argentina: Prov. Neuquén, Parque Nacional Lanén, Lago Quillen. *O. Kuhnemann 791 p.p.*, 10 November 1943 (CANL 2841).

Parmotrema demethylmicrophyllinicum Elix, Lich. Austral. Exs. Fasc. 5, No. 114 (1986).
ISOTYPE. Australia: Queensland, Haning Pinnacle (Dempseys Peak), 7 km E of Mt. Garnet. On granite rocks. *J.A. Elix* & *H. Streimann 16844*, 29 June 1984 (CANL 95337). Elix: Lich. Austral. Exs. No. 114.

Parmotrema queenslandense Elix, Lich. Austral. Exs. Fasc. 5, No. 116 (1986).
ISOTYPE. Australia: Queensland, near the summit of Mt. Leswell, 32 km S of Cooktown. On granite rocks. *J.A. Elix* & *H. Streimann 17365*, 5 July 1984 (CANL 95339). Elix: Lich. Austral. Exs. No. 116.

Parmotrema indicum Hale, Mycotaxon 5: 436 (1977).
ISOTYPE. India: Tamil Nadu, Silver Cascade, Kodaikanal, Palni Hills. Ad saxa in vicinitate fluminis. *M.E. Hale 43874*, January 1975 (CANL 69492). Vězda: Lich. Sel. Exs. No. 1573.

Peltigera kristinssonii Vitik., Ann. Bot. Fenn. 22: 291 (1985).
PARATYPE. United States: Colorado, Boulder Co., Boulder Canyon. *W.A. Weber,* 23 September 1975 (CANL 58199). Weber:

Lich. Exs. Colo. No. 484.

Peltigera malacea f. hasimotoi Asah. & Inum., Acta Phytotax. Geobot. 12: 8 (1943).
ISOTYPE. Japan: Prov. Etchu, Mt. Kaminotake. Over mosses. *Hasimoto* & *Asahina*, 24 July 1936 (CANL 20052). Kurokawa: Lich. Rar. Crit. Exs. No. 43.

Peltigera pacifica Vitik., Ann. Bot. Fenn. 22: 294 (1985).
ISOTYPE. Canada: British Columbia, 10 km N of Kitsumkalum Lake on E branch road. Terricolous. *T. Goward 81-2025*, 24 August 1981 (CANL 104553).

Peltula cylindrica Wetm., Ann. Missouri Bot. Gard. 57: 182 (1970).
ISOTYPE. United States: Georgia, Dekalb Co., Mt. Arabia, 20 km E von Atlanta. *C.M. Wetmore 19264*, 1969 (CANL 102538). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 33.

Pertusaria gymnospora Kantvilas, Lichenologist 22: 296 (1990).
PARATYPE. Australia: Tasmania, forest around Lake Judd, SW Tasmania. On dead wood, soil, rotten leaves. *G. Bratt 73/900*, 28 July 1973 (CANL 58194). Weber: Lich. Exs. Colo. No. 479.

Pertusaria neoscotica Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53, Bull. 132: 284 (1954).
HOLOTYPE. Canada: Nova Scotia, Cape Breton Island, Baddeck. On trunk of trees. *J. Macoun 1953, p.p.* 9 July 1898 (CANL 11479).

Pertusaria paramerae A. Crespo & Vězda, Anales Jord. Bot. Madrid 41: 252, 1984 (1985).
ISOTYPE. Spain: Prov. Soria, prope vicum judes, Paramera. Ad corticem *Juniperi thuriferae*. *A. Crespo* & *A. Vězda*, 24 May 1983 (CANL 89185). Vězda: Lich. Sel. Exs, No. 1979.

Pertusaria santamonicae Dibben, Publ. Biol. Geol. Milwaukee Public Mus. 5: 67 (1980).
PARATYPE. United States: California, San Mateo Co., San Francisco, below Spillway of San Andres Lake. *W. Jordan 769*, 13 September 1967 (CANL 27071).

Pertusaria suboculata Brodo & Dibben, Publ. Biol. Geol. Milwaukee Public Mus. 5: 72 (1980).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Moresby Island, Tasu. On *Alnus sinusta*. *I.M. Brodo 12825*, 28 July 1967 (CANL 30938).
PARATYPES. Canada: moresby Island. *I.M. Brodo 10896, 10980* & *14210* (CANL 29029, 27485 & 36493); United States: Oregon. *C.E. Fellows 32934* (CANL 38171).

Pertusaria subpupillaris Vězda, Vězda: Lich. Sel. Exs. Fasc. 20: 5 (1966).
ISOTYPE. United States: California, Mendocino Co., Caspar. On branches of *Pinus muricata*. *H. Sharsmith* & *I. Tavares 725*, 25

July 1961 (CANL 36511). Vězda: Lich. Sel. Exs. No. 491.
= P. glaucomela (Tuck.) Nyl.

Pertusaria subvelata G. K. Merrill, Bryologist 11: 111 (1908).
ISOTYPE. United States: Alaska, Skagway. On birch bark. *J. Macoun 87*, 4 September 1902 (CANL 11603).
= P. panyrga (Ach.) Massal.

Pertusaria sulcata Dibben, Publ. Biol. Mulwaukee Public Mus. 5: 73 (1980).
ISOTYPES. United States: Maine, North Lubec. On rail fences. *C.E. Cummings* & *E.A. Teller*, 3 July 1893 (CANL 19548 & 68955). Cummings: Dec. N. Amer. Lich. No. 136 & Lich. Boreali-Amer. No. 55.

Pertusaria victoriana Lamb, Farlowia 4: 463 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Lake Nahuel Huapí, Isla Victoria. On a large rock. *I.M. Lamb 5817*, 26 January 1950 (CANL 10590).

Phaeocalicium asciiforme Tibell, Symb. Bot. Upsal. 27(1): 200 (1987).
ISOTYPE. New Zealand: South Island, Westland, Arthur's Pass National Park, 3 km NNE of Otira. On branches of *Coprosma* sp. *L. Tibell 9944b* (CANL 99801). Tibell: Caliciales Exs. No. 168.

Phaeopeccania australiensis Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 10 (1990).
ISOTYPE. Australia: Küstenebene zwischen Denham und Nanga; in Vertiefungen auf horizontalen Felsplatten aus Muschelkalk. *A. Henssen 31366a*, 31 August 1987 (CANL 102556). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 49.

Phloeopeccania hispanica Henssen & Willems, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 10 (1990).
ISOTYPE. Spain: Andalusien, Sierra de Caho de Gata, Las Negras, Nordhang am Meeresufer. *A. Henssen* & *G. Willems 33008a*, 2-4 January 1989 (CANL 102555). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 48.

Phaeophyscia spinellosa Kashiw., Bull. Natl. Sci. Mus. Tokyo. Ser. B, 10: 46 (1984).
ISOTYPE. Japan: Honshu, Prov. Suruga, Fujieda-city. On rocks. *K. Sugiyama*, 10 August 1974 (CANL 87342). Kurokawa: Lich. Rar. Crit. Exs. No. 585.

Phlyctis pulveracea Lamb, Lilloa 26: 425 (1953),
HOLOTYPE. Uruguay: Dept. Florida, La Palma. On bark. *W.G. Herter 99430*, 1938 (CANL 12933).

Physcia duplicorticata W. Weber & Thomson, Mycotaxon 3: 102 (1975).
ISOTYPE. United States: California, Marin Co., 1.6 km E of junction Nicasio-Point Reyes road E of Inverness. On trunk

and branches of *Umbellularia californica*. *W.A. Weber & G. Kunkel*, 12 March 1975 (CANL 58191). Weber: Lich. Exs. Colo. No. 476.

Physcia hirsuta var. **echinella** Poelt, Mitt. Bot. Staatssamml. München 4: 298 (1962).
ISOTYPE. Italy: Appennino Ligure, Liguria, A un muro un poco ombroso, sopra Fabiano presso La Spezia. *C. & J. Poelt*, April 1962 (CANL 52894). Poelt: Lich. Alpium No 179.
= Phaeophyscia cernohorskyi (Nádv.) Essl.

Pilophorus cereolus var. **hallii** Tuck., Syn. North Amer. Lich. 1: 235 (1882).
ISOTYPE. United States: Oregon. *E. Hall*, 1871 (CANL 68789). Reliq. Tuck. No. 127.
= P. clavatus Th. Fr.

Placodium coralloides Tuck., Proc. Amer. Acad. Arts 6: 287 (1866).
ISOTYPE? United States: California. On coastal rocks near San Francisco. *H.N. Bolander*, 1865 (CANL 68790). Reliq. Tuck. No. 128.
= Caloplaca coralloides (Tuck.) Hult.

Placopsis alphoplacoides Lamb, Lilloa 13: 234 (1947).
ISOTYPE. New Zealand: South Island, Western Bot. Distr., Otira Gorge, rata belt. On earth. *G.E. & G.Du Rietz 2667*, 15 April 1927 (CANL 12558).
= P. trachyderma (Krempelh.) P. James

Placopsis alphoplacoides var. **clavifera** Lamb, Lilloa 13: 236 (1947).
ISOTYPE. New Zealand: South Island, Western Bot. Distr., Otira Gorge. On earth. *G.E. & G.Du Rietz 2668*, 15 April 1927 (CANL 12630).
= P. trachyderma (Kremp.) P. James var. clavifera (Lamb) P. James in Mark

Placopsis contortuplicata f. **fuegiensis** Lamb, Lilloa 13: 276 (1947).
ISOTYPE. Argentina: Tierra del Fuego, Sierra Alvear, ca. 20 km ENE of Ushuaia. On rocks in the alpine region. *R. Santesson 901*, 7 November 1940 (CANL 12560).

Placopsis dusenii Lamb, Lilloa 13: 215 (1947).
ISOTYPE. Chile: Magallanes, Isla Desolación, Puerta Angosto. *P. Dusén 199 p.p.*, 1896 (CANL 12568).

Placopsis gelidoides Du Rietz ex Lamb, Lilloa 13: 210 (1947).
ISOTYPE. New Zealand: South Island, Cass, Mt. Misery, in upper subalpine belt. *G.E. & G.Du Rietz 1468:15*, 9 January 1927 (CANL 12608).

Placopsis lateritioides Lamb, Lilloa 13: 222 (1947).
ISOTYPE. New Zealand: South Island, Cass, Mt. Misery, in upper subalpine belt. On rocks. *G.E. & G.Du Rietz 1468:16*, 9

January 1927 (CANL 12609).

Placopsis perrugosa f. **activa** Lamb, Lilloa 13: 272 (1947).
ISOTYPES. Chile: Magallanes, Isla Riesco, Mina Elena. On a stone block. *R. Santesson 2023a*, 29 April 1940 (CANL 12614 & 12621).

Placopsis salazina Lamb, Lilloa 13: 259 (1947).
ISOTYPE. New Zealand: Southland, Mt. Barber, above Deep Cove. On boulder. *G.E.* & *G.Du Rietz 2063:2*, 3 March 1927 (CANL 12635).

Plagiocarpa septemseptata R. Harris, Michigan Bot. 12: 37 (1973).
ISOTYPE. United States: North Carolina, Transylvania Co., Pisgah National Forest. On *Fraxinus*. *R.C. Harris 3373*, 29 May 1967 (CANL 37270).

Polyblastia cucurbitula Thomson, Bryologist 91: 89 (1988).
PARATYPES. Canada: British Columbia. *Brodo 21737* & *22417* (CANL 87604 & 86571).

Polyblastia sbarbaronis Servít, Ann. Mus. Civico Storia Nat. Giacomo Doria 66: 241 (1953).
ISOTYPE. Italy: Toscana, Vallombrosa, Saltino. Sbarbaro, July 1937 (CANL 1003).

Polyblastiopsis quercicola Brodo, Bull. New York State Mus. Sci. Surv. 410: 147 (1968).
ISOTYPE. United States: New York, Suffolk Co., Shorehem, Saint Joseph's Villa. N. Country Road. On *Quercus alba*. *I.M. Brodo 2651*, 7 July 1961 (CANL 227).
= Julella fallaciosa (Stizenb. ex Arnold) R. Harris

Polycauliona coralligera Hue, Expédit. Antarct. France 1903-05. p.10 (1908).
ISOTYPE. Antarctica: Graham Land (Palmer Peninsula), Booth (Wandel) Island. *Expédit. Antarct. France 1903-05, No. 277, 299*. 1904 (CANL 17955).
= Xanthoria candelaria (L.) Th. Fr.

Porina mangiferae Vainio, Univ. Calif. Publ. Bot. 12(1): 14 (1924).
ISOTYPE. Tahiti: Society Islands, Fautaua Valley. On leaves of *Mangifera*. *W.A. Setchell* and *H.E. Parks 5091, p.p.*, 3 June 1922 (CANL 103926).
= P. corruscans (Rehm) R. Sant.

Porocyphus kalbarrensis Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 9 (1990).
ISOTYPE. Australia: Kalbarri National Park, Red Bluff. Sandstein. *A. Henssen 31358a*, 29 August 1987 (CANL 102552). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 46.

Porpidia carlottiana Gowan, Bryologist 92: 39 (1989).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands,

Graham Island, Port Lewis. On rock. *I.M. Brodo 10489*, 26 June 1967 (CANL 27433).

Porpidia thomsonii Gowan, Bryologist 92: 54 (1989).
ISOTYPE. Canada: Northwest Territories, District of Keewatin, North end of Lake Ennadai. On boulders. *J.W. Thomson 20416*, 22 July 1960 (CANL 78044).

Protoparmelia loricata Poelt & Vězda, Vězda: Lich. Sel. Exs. Fasc. 92: 5 (1989).
ISOTYPE. Austria: Tirolia orientalis, alpes dicti Hohe Tauern, in valle Umbaltai. *J. Poelt & R. Türk,* 29 August 1988 (CANL 99233). Vězda: Lich. Sel. Exs. No. 2292.

Pseudocyphellaria anomala Brodo & Ahti, Mycotaxon 28: 95 (1987).
HOLOTYPE. United States: Washington. On trees. *A.S. Foster*, April 1908 (CANL 20272).

Pseudocyphellaria exanthematica Lamb, Farlowia 4: 435 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Lago Frías. On mossy trunk of *Coihue*. *I.M. Lamb 5986*, 11 November 1950 (CANL 3313).

Pseudocyphellaria hirsuta f. **leucosticta** Lamb, Farlowia 4: 436 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Futalaufquen. *O. Kühnemann 5449*, 1941 (CANL 3334).

Pseudocyphellaria rainierensis Imsh., Mycologia 42: 749 (1950).
ISOTYPE. United States: Washington, Mt. Rainier National Park, Ohanapecosh River above Panther Creek. *H.A. Imshaug 598*, 23 July 1948 (CANL 3369).

Pseudoparmelia crystallicola Kalb & Hale, Kalb: Lich. Neotr. Fasc. 7: 14 (1983).
ISOTYPE. Brazil: Minas Gerais, Serra do Espinhaço. Bei Diamantina, in einer offenen Felssteppenlandschaft. *K. Kalb & G. Plöbst*, 17 July 1978 (CANL 85932). Kalb: Lich. Neotr. No. 294.

Psilolechia leprosa Coppins & Purvis, Lichenologist 19: 35 (1987).
PARATYPE. Sweden: Härjedalen Prov., Tännäs par., Mt Gruvvålen, 0.1 km NE of Lake Glimsjön. On the walls and roof of a cave in the old copper mine. *R. Santesson 31128*, 10 August 1984 (CANL 95091). Moberg: Lich. Sel. Exs. Ups. No. 16.

Psora cerebriformis W. Weber, Mycotaxon 13: 104 (1981).
ISOTYPE. United States: Colorado, Montrose Co., 4 mi. E of Bedrock, on gypsum knolls, floor of Paradox Valley. *S. Shushan, R. Anderson & W.A. Weber 25501*, 30 May 1960 (CANL 20814). Weber: Lich, Exs. Colo. No. 24.

Psora montana Timdal, Bryologist 89: 266 (1986).
ISOTYPE. United States: Colorado, Grand Co., Tonahutu Creek Trail on NE end of Big Meadows. *R.A. Anderson 2386*, 6 July 1962 (CANL 124)

Psora pacifica Timdal, Bryologist 89: 268 (1986).
ISOTYPE. United States: California, Santa Barbara Co., Channel Islands, Santa Cruz Island, upper end of Islay Canyon. On bare earth. *W.A. Weber* & *C. Bratt*, 8 January 1986 (CANL 97963). Weber: Lich. Exs. Colo. No. 664.

Psora texana W. Weber, Mycotaxon 6: 178 (1977).
ISOTYPE. United States: Texas, Kerr Co., Guadalupe River Canyon, Hwy. 39, 22.4 km SW of Ingram, on road to Leakay. On vertical faces of limestone cliffs. *W.A. Weber*, 29 April 1974 (CANL 52198).
= Xanthopsorella texana (W. Weber) Kalb & Hafellner

Psoroma internectens Lamb, Farlowia 4: 427 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Menendez. On soil among mosses. O. *Kühnemann 4747*, 1940 (CANL 3049).

Psorotichia rimosa Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 11 (1990).
ISOTYPE. France: Languedoc, Ariège, Montagnes du Plantaurel, anstehender Kalk an der Strasse zwischen Mas d'Azile und Sabarat. *A. Henssen 29172a*, 5 June 1983 (CANL 102557). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 50.

Pterygiopsis australiensis Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 9 (1990).
ISOTYPE. Australia: Kalbarri National Park, Red Bluff. *A. Henssen 31357*, 29 August 1987 (CANL 102550). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 44.

Pterygiopsis canariensis Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 8 (1990).
PARATYPE. Canary Islands: Fuerteventura, Sukkulentenhalbwüste, auf basisch-kristallinem Gestein. *A. Henssen 32050*, 13-14 February 1988 (CANL 102548). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 42.

Pterygiopsis convoluta Henssen, Henssen: Lich. Cyanoph. Fungi Sax. Exs. Fasc. 2: 8 (1990).
ISOTYPE. Australia: Northampton Gorge, Konglomerat aus quarzitischem Sandstein im oberen Teil der Schlucht auf Sickerwasserflächen. *A. Henssen 31373a*, 1 September 1987 (CANL 102549). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 43.

Pterygium petersii Nyl., Syn. Meth. Lich. 1: 93 (1858).
ISOTYPE. United States: Alabama, Moulton. *T.M. Peters*, 1853 (CANL 68740). Reliq. Tuck. No. 61.
= Placynthium petersii (Tuck.) Burnham

Pyrenastrum gemmeum Tuck., Amer. J. Sci Arts Ser. 2, 25: 429

(1858).
SYNTYPE. United States: South Carolina, Santee Canal. *H.W. Ravenel*, 1853 (CANL 68791). Reliq. Tuck. No. 129.
= Parmentaria astroidea Fée

Pyrenopsis sojakii Vězda, Folia Geobot. Phytotax., Praha 14: 205 (1979).
ISOTYPE. Iran: "Persia australis", Bandar Lengeh. Ad lapides calcareos locis apricis. *J. Soják*, 25 April 1977 (CANL 73817).

Pyrenula cinerella var. **quadriloculata** Fink, Minnesota Bot. Stud. 2: 276 (1899).
ISOTYPE. United States: Minnesota, Grand Portage Island. *B. Fink 85*, 24 June 1897 (CANL 1384).
= unknown sp. (fide R. C. Harris, Michigan Bot. 12: 49 (1973)).

Pyrenula leucoplaca var. **pluriloculata** Fink, Minnesota Bot. Stud. 2: 709 (1902).
SYNTYPE. United States: Minnesota, Thief River Falls. On trees. *B. Fink 829,* 19 July 1900 (CANL 1335).
= Eopyrenula intermedia Coppins in Aptroot (1991).

Pyrenula macounii R. Harris, Michigan Bot. 12: 45 (1973).
HOLOTYPE. Canada: Ontario, Belleville. On trees. *J. Macoun*, April 1874 (CANL 1350).

Pyrenula neglecta R. Harris, Michigan Bot. 12: 45 (1973).
ISOTYPE. United States: New Hampshire, Plymouth. On beech trees. *C.E. Cummings*, 26 August 1893 (CANL 19561). Cummings: Dec. N. Amer. Lich. No. 150.
= Pyrenula pseudobufonia (Rehm) R. Harris

Pyrenula neglecta subsp. **occidentalis** R. Harris, Michigan Bot. 12: 51 (1973).
ISOTYPE. United States: Washington, Gate. On vine maple. *A.S. Foster*, 30 March 1912 (CANL 20502). Merrill: Lich. Exs. No. 275.
= P. occidentalis (R. Harris) R. Harris

Pyrenula nitidella var. **maculata** R. Harris, Weber: Lich. Exs. Colo. Fasc. 12, No. 443 (1975).
ISOTYPE. United States: Texas, McLennan Co., Canyon of the Middle Bosque River SW of Valley Mills and W of Waco. On saplings of a smooth-barked tree. *W.A. Weber*, 27 May 1974 (CANL 52193). Weber: Lich. Exs. Colo. No. 443.
= P. maculata (R. Harris) R. Harris

Pyrenula shirabeicola Kurok. & S. Nakan., Mem. Natl. Sci. Mus. Tokyo 4: 67 (1971).
ISOTYPE. Japan: Honshu, Prov. Hida, Mt. Ontake. On trunk of *Abies veitchii. S. Kurokawa 64172*, 13 August 1964 (CANL 45336). Kurokawa: Lich. Rar. Crit. Exs. No. 188.

Pyrenula thelomorpha Tuck., Gen. Lich. p. 275 (1872).

ISOTYPE. United States: South Carolina, Santee Canal. On *Ilex decidua. H.W. Ravenel 468* (CANL 68797). Reliq. Tuck. No. 135. = Anthracothecium thelomorphum (Tuck.) Zahlbr.

Pyxine daedalea Krog & R. Sant., Publ. Herb. Univ. Uppsala, Thunbergia 2: 7 (1986).
ISOTYPE. Costa Rica: Cartago Prov., 13 km SE of Cartago, 2.5 km SE of Orosi near the bridge over Rio Grande de Orosi. On a large boulder. *H. Krog & R. Santesson 29074*, 10 January 1979 (CANL 95093). Moberg: Lich. Sel. Exs. Ups. No. 17.

Ramalina americana Hale, Bryologist 81: 599 (1978).
ISOTYPES. United States: New Hampshire, Plymouth. On yellow birch. *C.E. Cummings*, 28 May 1891 (CANL 19451, 68913). Cummings: Dec. N. Amer. Lich. No. 43 & Lich. Boreali-Amer. No. 5.

Ramalina atlantica Culb., Brittonia 19: 350 (1967).
ISOTYPE. Scotland: Argyllshire, Ardnamurchan Peninsula, Portaick. On immense boulder. *W.L. Culberson 12254*, July 1964 (CANL 22578).

Ramalina bicolor Müll. Arg., Flora 60: 476 (1877).
ISOTYPE. Brazil: Bahia, Blanchet (CANL 42339).

Ramalina cactacearum Follm., Nova Hedwigia 14: 256 (1967).
ISOTYPE. Chile: Prov. Antofagasta, zerstreut im Dornenwerk von Säulenkakteen im *Tornabenietum intricatae. I.A. Follmann-Schrag & G. Follmann,* September 1965 (CANL 33001). Follmann: Lich. Exs. Sel. No. 51.

Ramalina euxini Vězda, Folia Geobot. Phytotax., Praha 14: 205 (1979).
ISOTYPE. Bulgaria: Distr. Burgas, in litore Euxini Ponti, 5 km ad meridiem versus ab oppido Sozopol. Ad scopulos andesiticos. *A, Vězda*, 20 September 1979 (1978 in protologue) (CANL 73831). Vězda: Lich. Sel. Exs. No. 1668.

Ramalina sideriza Zahlbr., Ann. K. K. Naturhist. Hofmus. 25: 246 (1911).
ISOSYNTYPE. United States: Hawaii, Island of Kauai. On trunk of trees. *A.A. Heller*, 28 June 1895 (CANL 20370). Merrill: Lich. Exs. No. 126.

Ramalina superfraxinea Follm. & Sánch.-Pinto, Philippia 4: 192 (1980).
ISOTYPE. Canary Islands: Tenerife, Vogelnestartig im halbschattigen Unterkronenteil solitärer Nadelbäume auf jungen Lavaströmen im *Ramalinetum subgeniculatae. G. Follmann & L. Sanchez-Pinto*, April 1978 (CANL 75275). Follmann: Lich. Exs. Sel. No. 314.

Ramalina tenuis Fries & Tuck. in Tuck., Amer. J. Sci. Arts Ser. 2, 25: 423 (1858).
ISOLECTOTYPE. United States: Texas, Mexican Bountary. Thickets of the Blanco. *C. Wright*, 1849 (CANL 68759). Reliq.

Tuck. No. 84.
LECTOPARATYPE. United States: South Carolina, Santee Canal, *H.W. Ravenel*, 1869 (CANL 68760). Reliq. Tuck. No. 85.

Ramalina tigrina Follm., Willdenowia 4: 227 (1966).
ISOTYPE. Chile: Prov. Antofagasta, gesellig auf Erosionsrippen. *I.A. Follmann-Schrag* & *G. Follmann*, September 1965 (CANL 32975). Follmann: Lich. Exs. Sel. No. 10.

Ramonia intermedia Kalb, Kalb: Lich. Neotr. Fasc. 6: 14 (1983).
ISOTYPE. Brazil: Minas Gerais, Serra da Mantiqueira, Oberhalb von Vila Monte Verde, etwa 30 km östlich von Camanducaia. In einem Gebirgsregenwald. *K. Kalb* & *H. Sipman*, 2 July 1979 (CANL 84791). Kalb: Lich. Neotr. No. 242.

Ramonia kandlerii Kalb, Kalb: Lich. Neotr. Fasc. 6: 14 (1983).
ISOTYPE. Brazil: Mato Grosso do Sul. Zwischen Rio Verde do Mato Grosso und Coxim. In einem dichten Cerradão in einer Bachschlucht. *K. Kalb*, 28 June 1980 (CANL 84792). Kalb: Lich. Neotr. No. 243.

Rhizocarpon compositum Lamb, Lilloa 14: 222 (1948).
ISOTYPE. Argentina: Prov. Tucumán, Quebrada de Lules. On rock outcrop. *I.M. Lamb 5132*, 5 October 1947 (CANL 18207).
= Buellia excellens H. Magn.

Rhizocarpon alaxensis Thomson, Nova Hedwigia 14: 471 (1967).
ISOTYPE. United States: Alaska, Franklin Bluffs on the Sagavanirktok River. On rocks. *J.W. Thomson, S. Shushan* & *J. Koranda 10859*, 30 July 1958 (CANL 44991).

Rhizocarpon atlanticum Lamb, J. Bot. 78: 132 (1940).
PARATYPE. England: Cornwall, Rocky Valley near Boscastle. *I.M. Lamb 877*, 1939 (CANL 6111).
= R. constrictum Malme

Rhizocarpon barilochense Räsänen, Arch. Soc. Zool.-Bot. Fenn. "Vanamo" 6(2): 85 (1952).
ISOTYPE. Argentina: Patagonia, Prov. Río Negro, Cerro Catedral near Bariloche. On rocks. *I.M. Lamb 5958*, 10 February 1950 (CANL 27348).

Rhizocarpon cumulatum Thomson, Nova Hedwigia 14: 461 (1967).
ISOTYPE. United States: Alaska, Pitmegea River, 15 miles upstream from Cape Sabine. On shaded layers at top of bluff. *J.W. Thomson 10571*, 12 July 1958 (CANL 45003).

Rhizocarpon hensseniae Brodo, Biblioth. Lichenol. 38: 32 (1990).
HOLOTYPE. Canada: British Columbia, Queen Charlotte Islands, Graham Island, Seal Inlet in Rennell's Sound. On exposed stone. *I.M. Brodo 10264*, 23 June 1967 (CANL 98871).

Rhizocarpon inimicum Poelt & Vězda, Herzogia 6: 471 (1984).

ISOTYPE. Spain: Catalonia, montes Montseny, Matagalls. Ad saxa schistosa, in thallo *Lecanorae rupicolae*. *J. Poelt* & *A. Vězda*, 28 May 1983 (CANL 89186). Vězda: Lich. Sel. Exs. No. 1980 (1970 in protologue).

Rhizocarpon renneri Poelt, Planta 51: 306 (1958).
ISOTYPE. Austria: Samnaungruppe, Tirol. Steilfläche des grossen Blockes am Kölner Haus. *J. Poelt*, July 1958 (CANL 52817). Poelt: Lich. Alpium No. 100.

Ricasolia beckettii Stirton, Trans. & Proc. New Zealand Inst. 30: 392 (1897).
ISOTYPE. New Zealand: Mount Bossu, Banks Peninsula. On *Podocarpus totara*. *T.W.N. Beckett L. 3*, 1893 (CANL 3387).
= Pseudocyphellaria coriacea (T. D. Hook. & Taylor) D. Galloway & P. James ?

Rimularia fuscosora Muhr & Tønsberg, Nord. J. Bot. 8: 649 (1989).
ISOTYPE. Sweden: Västerbotten Prov., Skellefteå par., ca. 3 km NE of Mt Stora Blåbergsliden, by the small stream Djupgravbäcken. On *Alnus incana*. *L.-E. Muhr* 7540, 8 August 1984 (CANL 102833). Moberg: Lich. Sel. Exs. Ups. No 94.

Rinodina afghanica M. Steiner & Poelt, Pl. Syst. Evol. 155: 139 (1987).
ISOTYPE. Afghanistan: Prov. Samangan, 1 km W des Passes Kotal-Mirza Atbili. *M. Steiner Ste 50/3*, 6 June 1970 (CANL 104080). Steiner & Poelt: Lich. Afghanica No. 46.

Rinodina ascociscana Tuck., Gen. Lich. p. 124 (1872).
ISOSYNTYPE. United States: New Hampshire, White Mountains. *E. Tuckerman* (CANL 23267). Reliq. Tuck. No. 86.

Rinodina calculiformis W. Weber, Bryologist 67: 473 (1964).
ISOTYPE. Mexico: Baja California, Isla Guadalupe, Melpomene Cove. On volcanic scoria. *W.A. Weber* & *C.J. McCoy*, 21 April 1963 (CANL 20883). Weber: Lich. Exs. Colo. No. 94.

Rinodina dakotensis H. Magn., Bot. Not. 1947: 40 (1947).
ISOTYPES. United States: South Dakota, Brookings. On plum trees. *T.A. Williams*, 11 May 1895 (CANL 19580, 69031). Cummings: Dec. N. Amer. Lich. No. 169b & Lich. Boreali- Amer. No. 163b.

Rinodina humilis H. Magn., Bot. Not. 1939: 132 (1939).
ISOTYPE. Sweden: Västergötland, Björketorp, Stenbacka. On moist stones. *A.H. Magnusson*, 26 March 1934 (CANL 20147). Magnusson: Lich. Sel. Scand. Exs. No. 324.

Rinodina milliaria f. **obscura** H. Magn., Bot. Not. 1947: 19 (1947).
ISOTYPE. United States: Maine, Rockland. On bark of young trees. *G.K. Merrill 163*, 21 April 1910 (CANL 20406). Merrill: Lich. Exs. No. 163.
= R. dakotensis H. Magn.

Rinodina oregana H. Magn., Bot. Not. 1947: 49 (1947).
ISOTYPES. United States: Oregon, Forest Grove. On *Acer macrophyllum*. *A.R. Sweetser*, December 1899 (CANL 19739, 69098). Cummings: Dec. N. Amer. Lich. No. 330 & Lich. Boreali-Amer. No. 262.

Rinodina pallida H. Magn., Bot. Not. 1939: 313 (1939).
ISOTYPE. Sweden: Västergötland, Broddetorp, Fjällakra. On a bridge of sandstone. *A.H. Magnusson*, 10 June 1938 (CANL 20148). Magnusson: Lich. Sel. Scand. Exs. No. 325.

Rinodina sabulosa Tuck., Lich. Calif. p. 21 (1866).
ISOTYPE. United States: California. *H.N. Bolander*, 1865 (CANL 68761). Reliq. Tuck. No. 87.
= R. conradii Körber

Roccella galapagoensis Follm., Nova Hedwigia 15: 337 (1969).
ISOTYPE. Ecuador: Galapagos Islands, Isla Santa Cruz. On seaward vertical sides of bouders. *W.A. Weber*, 13 February 1964 (CANL 20901) Weber: Lich. Exs. Colo. No. 112.

Roccellina luteola Follm., Nova Hedwigia 14: 239 (1967).
ISOTYPE. Chile: Prov. Antofagasta, koloniebildend an Stirnflächen und Überhängen von Diorithöckern im *Roccelletum portentosae*. *G. Follmann*, September 1965 (CANL 33004). Follmann: Lich. Exs. Sel. No. 54.

Roccellina olivacea Follm., Philippia 4: 111 (1979).
ISOTYPE. Chile: Prov. Coquimbo, gesellig an schattseitigen, durch Gischtstaub beeinflussten Stirnflächen und Überhängen von Dioritfelsen im *Roccelletum portentosae*. Küstenformation nördlich der Limarimündung. *G. Follmann*, September 1965 (CANL 71806). Follmann: Lich. Exs. Sel. No. 296.

Sagenidiopsis merrotsii R. W. Rogers & Hafellner, Lichenologist 19: 402 (1987).
ISOTYPE. Australia: New South Wales, Border Ranges National Park, Brindle Creek. Ad truncum *Nothofagi moorei*. *J. Hafellner, P. Merrotsy & R. Rogers*, 30 August 1986 (CANL 97328). Vězda: Lich. Sel. Exs. No. 2226.

Sarrameana tasmanica Vězda & Kantv., Lichenologist 20: 179 (1988).
ISOTYPE. Australia: Tasmania, Little Fisher River. Ad corticem arboris. *G. Kantvilas & J. Jarman 63/87*, 15 May 1987 (CANL 97302). Vězda: Lich. Sel. Exs. No. 2200.

Schistophoron variabile Tibell, Lichenologist 14: 242 (1982).
ISOTYPE. Costa Rica: Limón, 1 km NW of Pto. Limón. On trunk of *Cocos nucifera*. *L. Tibell 8514,* 9 January 1979 (CANL 87469). Tibell: Caliciales Exs. No. 96.

Schizopelte californica Th. Fr., Flora 58: 143 (1875).
ISOTYPE. United States: California. *G. Eisen*, 1874 (CANL 2122).
= Combea californica (Th. Fr.) Follm. & Geyer

Setaria trichodes Michaux, Fl. Boreal.-Amer. 2: 331 (1803).
ISOTYPE. Canada: Ad ramulos putridos (CANL 34981).
= Bryoria trichodes (Michaux) Brodo & D. Hawksw. subsp. trichodes.

Skyttea tephromelarum Kalb & Hafellner, Kalb: Lich. Neotr. Fasc. 10: 15 (1988).
ISOTYPE. Kenya: Nanyuki District zwischen Naro Moru und Nanyuki. *K. Kalb & A. Schrögl*, 18 August 1985 (CANL 102737). Kalb: Lich. Neotr. No. 449.

Sphaerophorus notatus Tibell, Publ. Herb. Univ. Uppsala 10: 9 (1982).
ISOTYPE. New Zealand: Otago, Mount Aspiring National Park, 10 km NNE of Makaroa. On trunk of *Nothofagus menziesii*. *L. Tibell 10604*, 23 January 1981 (CANL 82051). Tibell: Caliciales Exs. No. 73.

Sphaerophorus ramulifer Lamb, Farlowia 4: 426 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Río Negro, Lago Frías. On trunk of *Fitzroya* near the lake. *I.M. Lamb 5977*, 11 February 1950 (CANL 1751).

Squamaria configurata f. **diffracta** Oxner, Ukrayins'k. Bot. Zhurn. 4: 53 (1928).
ISOTYPE. Ukraine: Ditio Kirowogradensis. Ad safa granitica ad flum. Subakleji in viciniis opp. Kirowograd. *A. Oxner*, 22 May 1926 (CANL 11909).
= Lecanora laatokkaensis (Räsänen) Poelt

Stephanocyclos henssenianus Hertel, Hertel: Lecideaceae Exs. Fasc. 5, No. 96 (1983).
ISOTYPE. Subantarctic Islands: Marion Island, Nellie Humps, zwischen Junior's Kop und Meteorologischer Station. Niedrige, bizarre Lava-Felsen im moorigen Gelände. *H. Hertel*, 13 April 1982 (CANL 85425). Hertel: Lecideaceae Exs. No. 96.

Stereocaulon alpinum var. **erectum** Frey, Rabenh. Kryptog. Fl. 9 Abt. 4, 1. Hälfte: 164 (1932).
ISOLECTOTYPES. Switzerland: Graubünden, Engadin, Samaden, Kies- und Sandalluvionen des Inn nahe beim Bahnhof. *E. Frey 1636*, 1931 (CANL 77611, 63390). Poelt: Pl. Graecenses No. 232.

Stereocaulon arbuscula var. **aberrans** Asah., J. Jap. Bot. 19: 282 (1943).
ISOLECTOTYPE. Japan: Honshu, Prov. Musashi, Nippara. *I. Sasaki*, 1940 (CANL 48276).
= Leprocaulon arbuscula (Nyl.) Nyl. (Ch. strain II.)

Stereocaulon argodes Nyl., Compt. Rend. Hebd. Séances Acad. Sci. 83: 87 (1876).
ISOTYPE. New Zealand: Campbell Island. *Filhol*, 1874 (CANL 67862).
= S. argus J. D. Hook. & Taylor

Stereocaulon argus var. **stenospermum** Lamb, Farlowia 4: 460 (1955).
HOLOTYPE. Argentina: Prov. Río Negro, near foot of Frías Glacier S. of Lago Frías. On dry exposed rocks. *I.M. Lamb 6088*, 1950 (CANL 63410).
ISOTYPE. (CANL 77621). Poelt: Pl. Graecenses No. 242.
= S. stenospermum (Lamb) Lamb

Stereocaulon azulense Yoshimura & W. Weber, Mycotaxon 27: 494 (1986).
ISOTYPE. Ecuador: Galápagos Islands, Isla Isabela, SW coast, Cerro Azul. On boulders. *W.A. Weber & H. Beck*, 17 January 1984 (CANL 97944). Weber: Lich. Exs. Colo. No. 645.

Stereocaulon botryosum f. **depressum** Frey, Rabenhorsts Kryptog. Fl. 9 (4,1): 126 (1932).
ISOLECTOTYPE. Norway: Nordland, Umbukten. On sunny places. *A.H. Magnusson 9040*, 1924 (CANL 70674).
= S. depressum (Frey) Lamb

Stereocaulon botryosum f. **pygmaeum** H. Magn., Ark. Bot. 33A: 91 (1946).
ISOTYPE. Sweden: Lycksele Lappmark, Tärna, Brakkffället. On irrigated rock. *A.H. Magnusson 8084*, 1924 (CANL 75018).
= S. spathuliferum Vainio f. pygmaeum (H. Magn.) Lamb

Stereocaulon capense Lamb, Lilloa 26: 416 (1953).
HOLOTYPE. South Africa: Western Cape Province, Tulbagh Division, Great Winterhoek. On rock face. *E. Esterhuysen 19862 p.p.*, 1951 (CANL 63391).
= S. corticatulum Nyl. var. capense (Lamb) Lamb

Stereocaulon colensoi var. **reagens** Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 2: 24 (1932).
ISOSYNTYPE? Chile: Fuegia occ., Fjordo Finlandia, supra rupium. *H. Roivainen*, 1929 (CANL 70923).
= S. glabrum (Müll. Arg.) Vainio

Stereocaulon condensatum var. **sorediatum** Harm., Bull. Acad. Int. Géogr. Bot. 22: 157 (1913).
ISOTYPE. France: Hérault, La Salvetat. Sur des rochers schisteux, terreux. *F. Marc* (CANL 71016). Claud. & Harm.: Lich. Gall. Praecip. Exs. No. 474.

Stereocaulon coralloides Fr., Fr.: Lich. Suec. Exs. No. 118 (1817).
ISOTYPE. Sweden: no locality or date designated (CANL 70733).
= S. dactylophyllum Flörke

Stereocaulon coralloides var. **flabellatum** Frey, Rabenhorsis Kryptog. Fl. 9 (4,1): 196 (1932).
ISOLECTOTYPE. Germany: Bayem, Böhmerwald, Bayrisch-Eisenskein, Hochbergplatte, schatlig. *J. Hillmann*, 2 October 1930 (CANL 70680)
= S. dactylophyllum Flörke var. flabellatum (Frey) Grumm.

Stereocaulon coralloides var. **occidentale** H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl. Ser. 4, 30: 27 (1926).
ISOLECTOTYPE. Sweden: Bohuslän, Dragsmark. *A.H. Magnusson*, 1915 (CANL 70696).
= S. dactylophyllum Flörke var. occidentale (H. Magn.) Grumm.

Stereocaulon cornutum var. **corallizans** Lamb, J. Hattori Bot. Lab. 43: 251 (1977).
ISOTYPE. Costa Rica: Prov. Heredía, Cerro Central de Zurquí. *C.W. Dodge, J. Valerio R., W.S. Thomas & R. Valerio 6119*, 1929 (CANL 63389).

Stereocaulon corticatulum var. **complanatum** Lamb, J. Hattori Bot. Lab. 43: 289 (1977).
ISOTYPE? New Zealand: Südinsel, Otago, Taieri Mouth, Küstenfelsen. *J. Murray 9742 (1421* in protologue), 1958. (CANL 77612). Poelt: Pl. Graecenses No. 233.

Stereocaulon corticatulum var. **procerum** Lamb, Farlowia 4: 462 (1955).
HOLOTYPE. Argentina: Prov. Río Negro, between Lago Frías and Frías Glacier. On rocks. *I.M. Lamb 6086*, 1950 (CANL 63400).
ISOTYPE. (CANL 77619).
≡ S. melanopotamicum Lamb

Stereocaulon crambidiocephalum Lamb, J. Hattori Bot. Lab. 43: 290 (1977).
ISOTYPE. Peru: Dept. Cuzco, Prov. Paucartambo, Llulluchayocc. On rock. *C. Vargas 4301*, 1944 (CANL 63392).

Stereocaulon dendroides Asah., J. Jap. Bot. 36: 231 (1961).
ISOTYPE. Japan: Shikoku, Mt. Kenzan. *F. Fujikawa*, 1934 (CANL 63393).

Stereocaulon denudatum var. **umbricola ("umbricolum")** Frey, Rabenhorsts Kryptog. Fl. 9 (4,1): 134 (1933).
ISOTYPE. Switzerland: Berner Oberland, Grimsel, way towards Nägelisgrätli. On granite rock. *E. Frey 1429*, 1930 (CANL 63414).
= S. vesuvianum Pers. var. nodulosum (Wallr.) Lamb f. umbricola (Frey) Lamb

Stereocaulon dusenii Lamb, J. Hattori Bot. Lab. 43: 292 (1977).
ISOTYPE. Chile: Magallanes, Isla Desolación, Puerto Angosto. On rocks. *P. Dusén 186*, 1896 (CANL 63394).

Stereocaulon esterhuysenae Lamb, Lilloa 26: 417 (1953).
HOLOTYPE. South Africa: Western Cape Province, Tulbagh Division, Great Winterhoek. On a rock face. *E. Esterhuysen 19862 p.p.*, 1951 (CANL 63395).

Stereocaulon evolutoides var. **paschaleoides** Hav., Årbok. Univ. Bergen, Naturvitensk. Rekke 12: 1720 (1954).
ISOTYPE. Norway: Granvin, Gamladaemmo, near Skålsaete. On gneiss boulders. *J. Havaas* (CANL 63409).

= S. saxatile H. Magn. f. paschaleoides (Hav.) Lamb

Stereocaulon exutum Nyl., Lich. Japon. p. 18 (1890).
ISOTYPE. Japan: Fusijama. *E. Almquist*, 1879 (Vega Exped., 1878-1880) (CANL 70910).

Stereocaulon fastigiatum f. **confluens** H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl., Ser. 4, 30: 35 (1926).
ISOTYPE. Sweden: Torne Lappmark, par. Jukkasjärvi, Kopparåsen. *A.H. Magnusson 6073*, 1921 (CANL 70726).
= S. depressum (Frey) Lamb

Stereocaulon fastigiatum var. **dissolutum** H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl. Ser. 4, 30: 36 (1926).
LECTOPARATYPE. Norway: Nordland, Umbukten, Krabbfjäll. *A.H. Magnusson 9040*, 1924 (CANL 75616).
= S. spathuliferum Vainio f. congestum (H. Magn.) Lamb

Stereocaulon glareosum var. **brachyphylloides** Lamb, J. Wash. Acad. Sci. 41: 196 (1951).
ISOTYPES. United States: Alaska, Brooks Range, Anaktuvuk Pass. On soil. *G.A. Llano & N. Weber 527*, 1949 (CANL 63397, 77614). Poelt: Pl. Graecenses No. 235.

Stereocaulon halei Lamb, J. Hattori Bot. Lab. 43: 294 (1977).
ISOTYPE. Malaysia: Pahang, unterhalb Ganong Brinchang. *M.E. Hale*, 1965 (CANL 77615). Poelt: Pl. Graecenses No. 236.

Stereocaulon intermedium f. **compactum** Lamb, J. Hattori Bot. Lab. 43: 223 (1977).
ISOTYPES. United States: Alaska, Aleutian Islands, Rat Island, Amchitka, near Consantine Harbor. *G.A. Llano 1277*, 1949 (CANL 63385, 77617). Poelt: Pl. Graecenses No. 238.

Stereocaulon japonicum var. **subfastigiatum** Asah., J. Jap. Bot. 35: 289 (1960).
ISOTYPE. Japan: Honshu, Prov. Owari, Kiso River, Inuyama. *Y. Asahina 1201*, 1938 (CANL 63398).

Stereocaulon japonicum var. **tokioense** Lamb, J. Jap. Bot. 44: 265 (1969).
HOLOTYPE. Japan: Honshu, Tokyo. On stone wall of the University. *Y. Asahina 650*, 1943 (CANL 63399).

Stereocaulon leprocauloides Lamb, Bryologist 74: 193 (1971).
ISOTYPES. Papua New Guinea: Morobe District, Mt. Kaindi near Wau. *W.A. Weber & D. McVean*, 19 June 1968 (CANL 33463, 77618). Weber: Lich. Exs. Colo. No. 299; Poelt: Pl. Graecenses No. 239.

Stereocaulon melanopotamicum Lamb, J. Hattori Bot. Lab. 43: 296 (1977).
(see Stereocaulon corticatulum var. procerum Lamb).

Stereocaulon meyeri f. **tucumanum** Lamb, J. Hattori Bot. Lab. 43: 297 (1977).

ISOTYPE. Argentina: Prov. Tucumán, Dept. Chicligasta, between La Cascada and Las Cuevas. On rock. *T. Meyer*, 1949 (CANL 63401).

Stereocaulon montagneanum Lamb, J. Jap. Bot. 40: 272 (1965).
ISOTYPE. Malaysia: Cameron Highland, On exposed rocks. *M. Togashi 62236*, 1-3 February 1962 (CANL 34168). Kurokawa: Lich. Rar. Crit. Exs. No. 142.

Stereocaulon myriocarpum var. **altaicum** Lamb, J. Hattori Bot. Lab. 43: 225 (1977).
ISOTYPE. Kazakhstan: Siberia, Gub. Semipalatinsk, Altai Mts., Katon-Karagai. *P. Krylov & L. Sergievskaya 8*, 1928 (CANL 74958).

Stereocaulon nanodes f. **schadeanum** Lamb, J. Hattori Bot. Lab. 43: 242 (1977).
ISOTYPE. Germany: Sachsen, Freiberg. *A. Schade 1767*, 1927 (CANL 63402).

Stereocaulon novoarbuscula Asah., J. Jap. Bot. 19: 283 (1943).
ISOLECTOTYPE. Japan: Shikoku, Prov. Tosa, Mt. Otoyama. *F. Fujikawa*, 1931 (CANL 48290).
= Leprocaulon pseudoarbuscula (Asah.) Lamb & Ward

Stereocaulon octomerelloides Asah., J. Jap. Bot. 45: 68 (1970).
ISOTYPE. Japan: Honshu, Prov. Etigo, Sasagamine Pasture. *Y. Asahina 1521*, 1949 (CANL 63403).
= S. octomerellum Müll. Arg.

Stereocaulon papuanum Lamb, J. Hattori Bot. Lab. 43: 225 (1977).
ISOTYPE. Papua New Guinea: Central Division, Mt. Albert Edward. *L.J. Brass 4394a*, 1933 (CANL 63404).

Stereocaulon paschale var. **alpinum** f. **flabellans** Lamb, Farlowia 4: 457 (1955).
HOLOTYPE. Argentina: Prov. Río Negro, Cerro Rigi near Lago Frías. On the ground between rocks and stones. *I.M. Lamb 5787*, 1950 (CANL 63396).
ISOTYPE. (CANL 77613). Poelt: Pl. Graecenses No. 234.
= S. glabrum (Müll. Arg.) Vainio f. flabellans (Lamb) Lamb

Stereocaulon paschale f. **colligatum** Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53, Bull. No. 132: 273 (1954).
HOLOTYPE. Canada: Nova Scotia, Victoria Co., Cape Breton Island, Ingonish, Middle Head. On granitic rocks. *I.M. Lamb 6946*, 29 July 1952 (CANL 10301).
= S. paschale (L.) Hoffm. f. paschale

Stereocaulon paschale subsp. **evolutoides** f. **laxatum** Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53, Bull. No. 132: 275 (1954).
ISOTYPE. Sweden: Värmland, Sillerud, Jarnsjön. *A.H.*

Magnusson, 1912 (CANL 71061).

Stereocaulon paschale v. **evolutoides** f. **sorediatum** H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl. Ser. 4, 30: 36 (1926).
ISOTYPE. Sweden: Värmland, par. Sillernd, Järnsjön. *A.H. Magnusson*, 1912 (CANL 71078).
= S. saxatile H. Magn. f. sorediatum (H. Magn.) Lamb

Stereocaulon paschale var. **serpens** Th. Fr., De Stereoc. et Pilophor. Comment p. 33 (1857).
ISOTYPE. Sweden: Uppsala, Vitulfsberg. *Th. Fries*, 1852 (CANL 70990).
= S. paschale (L.) Hoffm.

Stereocaulon patagonicum Lamb, Farlowia 4: 454 (1955).
HOLOTYPE. Argentina: Prov. Chubut, Lago Menéndez, W. end. On sandy gravelly shore of lake. *I.M. Lamb 5790*, 1950 (CANL 63405).
ISOTYPE. (CANL 77616). Poelt: Pl. Graecenses No. 237.
= S. glabrum (Müll. Arg.) Vainio

Stereocaulon patagonicum f. **subirregulare** Lamb, Farlowia 4: 456 (1955).
HOLOTYPE. Argentina: Prov. Río Negro, Lago Frías, Cerro Rigi, near summit. In cleft between stones. *I.M. Lamb 5789*, 1950 (CANL 63406).
= S. glabrum (Müll. Arg.) Vainio

Stereocaulon philippinense Räsänen, Arch. Soc. Zool.-Bot. Fenn. "Vanamo" 3: 79 (1949).
ISOTYPE. The Philippines: Negros, Canlaon Volcano. Terricola. *E.D. Merrill 6874*, April 1910 (CANL 71010).

Stereocaulon pileatum f. **macrum** H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl. Ser. 4, 30: 70 (1926).
ISOTYPE. Sweden: Ljung, Kolbengtsered. On rock. *A.H. Magnusson 9513*, 13 August 1925 (CANL 71041).
= S. pileatum Ach.

Stereocaulon pileatum var. **nipponicum** Lamb, J. Hattori Bot. Lab. 43: 227 (1977).
HOLOTYPE. Japan: Jiushiu, Prov. Higo, Aida. *K. Maebara*, 1927 (CANL 63407).

Stereocaulon proximum var. **gracilius** Müll. Arg., Rev. Mycol. (Toulouse) 1: 164 (1879).
ISOTYPE? Colombia "Nova Granata": La Horqueta prope Dolores. *André* (coll. no. = *2813 p.p.* in holotype), 1876 (CANL 77638).
= S. ramulosum (Sw.) Räusch. var. gracilius (Müll. Arg.) Lamb

Stereocaulon pseudoarbuscula Asah., J. Jap. Bot. 19: 282 (1943).
ISOLECTOTYPE. Japan: Honshu, Prov. Musashi, Titibu. *Y. Asahina 1249*, 1933 (CANL 48292).
= Leprocaulon pseudoarbuscula (Asah.) Lamb

Stereocaulon pseudomassartianum Lamb, Bot. Jahrb. Syst. 86: 246 (1967).
ISOSYNTYPES. The Philippines: Luzon, Mountain Prov., Ifugao Subprov. On trail between Banaue and Mt. Polis. On earth. *A.W. Herre*, 1923 (CANL 71040, 77620). Poelt: Pl. Graecenses No. 241.

Stereocaulon pygmaeum Vainio, Voyage S. Y. Belgica, Bot. p. 15 (1903).
ISOTYPE. Antarctica: Graham Land (Palmer Peninsula), Cape Anna Osterrieth. *Exped. Antarctica Belge 1897-99, No. 201.* (CANL 12807).
= Lecania brialmontii (Vainio) Zahlbr.

Stereocaulon ramulosum var. **pulvinare** f. **crebratum** Lamb, J. Hattori Bot. Lab. 43: 283 (1977).
ISOTYPE. New Zealand: South Island, Port Chalmers near Dunedin. On rock. *J.S. Thomson D.15, T. 696* (CANL 63408).

Stereocaulon speciosum Lamb, Farlowia 4: 458 (1955).
HOLOTYPE. Argentina: Prov. Chubut, Lago Menendez. On mossy gravelly soil. *I.M. Lamb 6069*, 1950 (CANL 63387).
ISOTYPE. (CANL 77623). Poelt: Pl. Graecenses No. 244.
= S. verruciferum Nyl.

Stereocaulon speciosum var. **surreptans** Lamb, Farlowia 4: 459 (1955).
HOLOTYPE. Argentina: Prov. Río Negro, Cerro Rigi near Lago Frías, near summit. On detritus. *I.M. Lamb 6098*, 1950 (CANL 63388).
ISOTYPE. (CANL 77624). Poelt: Pl. Graecenses No. 245.
= S. verruciferum Nyl. var. surreptans (Lamb) Lamb

Stereocaulon subalbicans Lamb, Bryologist 60: 220 (1957).
ISOTYPE. Chile: Prov. Coquimbo, La Serena, Cerro Los Loros. *R. Santesson 2530*, 1940 (CANL 48278).
= Leprocaulon subabicans (Lamb) Lamb & Ward

Stereocaulon subcoralloides f. **sorediascens** Lamb, J. Hattori Bot. Lab. 43: 235 (1977).
HOLOTYPE. Russia: Karelia ladogensis, Kurkijoki, Kuuppala, Jäävuori. On rock. *V. Räsänen*, 1931 (CANL 63411).

Stereocaulon tennesseense H. Magn., Ark. Bot. 30A: 48 (1941).
ISOTYPE. United States: Tennessee, Great Smoky Mountains, near Alum Cave. On moist rocks. *G. Degelius*, 1939 (CANL 75021).

Stereocaulon tennesseense var. **nigrofastigiatum** Lamb, J. Hattori Bot. Lab. 43: 236 (1977).
HOLOTYPE. United States: New York State, Adirondacks, Mt. Colden near Lake Placid. On rocks. *J.L. Lowe*, 1952 (CANL 63412).
ISOTYPE. (CANL 77622). Poelt: Pl. Graecenses No. 243.

Stereocaulon tomentosum var. **compactum** Frey, Rabenhorsts

Krypt. Fl. 9 (4,1): 187 (1932).
ISOTYPE? Germany: Sachsen, Brambach im Vogtland Sohle in altem Steinbruch, Granit. *A. Spindler*, 1908 (CANL 74962).

Stereocaulon tomentosum var. **capitatum** Lamb, J. Hattori Bot. Lab. 43: 239 (1977).
HOLOTYPE. Argentina: Prov. Tucumán, Valle de Tafi, W. slope of Cumbre Potrerillo. *I.M. Lamb 5309*, 1947 (CANL 63386).

Stereocaulon verruculigerum var. **formosanum** Asah., J. Jap. Bot. 35: 295 (1960).
ISOLECTOTYPE. Taiwan: Rengechi. *Y. Asahina 222*, 1925 (CANL 63413).
= S. verruculigerum Hue var. verruculigerum

Stereocaulon vesuvianum f. **verrucosum** Lamb, J. Hattori Bot. Lab. 43: 247 (1977).
ISOTYPE. United States: Alaska, Aleutian Islands, Attu. *G. A. Llano 1463 p.p.*, 1949 (CANL 77625). Poelt: Pl. Graecenses No. 246.

Stereocaulon vimineum Th. Fr., De Stereoc. & Pilophor. Comment p. 13 (1857).
ISOTYPE? Mexico: Tiuzutlán. *Liebmann 73*, 1841 (CANL 75624).
= S. ramulosum (Sw.) Räusch.

Stereocaulon weberi Lamb, J. Hattori Bot. Lab. 43: 258 (1977).
ISOTYPES. Ecuador: Galápagos Islands, Isla Santa Cruz, summit of Mount Crocker. *W.A. Weber* & *J. Lanier*, 15 April 1976 (CANL 58209, 77626). Weber: Lich. Exs. Colo. No. 494; Poelt: Pl. Graecenses No. 247.

Sticta oregana Tuck., Bull. Torrey Bot. Club 5: 20 (1874).
ISOTYPE. United States: Oregon. *E. Hall*, 1871 (CANL 68763). Reliq. Tuck. No. 90.
= Lobaria oregana (Tuck.) Müll. Arg.

Strangospora senecionis Lambinon & Vězda, Folia Geobot. Phytotax., Praha 14: 206 (1979).
ISOTYPE. Zaire: Prov. Kivu, Birunga montes, in planitie Rukumi montis ignivomi Karisimbi. Ad corticem et lignum truncorum vetustorum. *J. Lambinon 72/230*, 22 January 1972 (CANL 73820). Vězda: Lich. Sel. Exs. No. 1657.

Sulcaria badia Brodo & D. Hawksw., Opera Bot. 42: 146 (1977).
ISOTYPE. United States: Oregon, Philomath. On old apple trees. F.P. Sipe 669 (CANL 29671).
Note: This specimen is a portion of the same number designated by Gyelnik as the type of Alectoria pseudofuscescens Gyelnik. The holotype in BP, however, is quite different. (fide Brodo & Hawksworth 1977. Opera Bot. 42: 147).

Sulcaria isidiifera Brodo, Mycotaxon 27: 115 (1986).
HOLOTYPE. United States: California, San Luis Obispo Co., Los

Osos Oaks State Reserve, Los Osos Valley Road. *C. Bratt & J. Larson 3871*, 8 January 1984 (CANL 88639).
PARATYPE. United States: California. *M.E. Hale 57816* (CANL 80150).

Tephromela elixii Kalb, Kalb: Lich. Neotr. Fasc. 12: 15 (1991).
ISOTYPE. Venezuela: Merida, Distr. Rangel, Páramo zwischen der Laguna Mucubají und dem Pico Mucuñuque, etwa 15 km SE von Apertaderos. *K. & A. Kalb*, 16 August 1989 (CANL 103793). Kalb: Lich. Neotr. No. 522.

Tephromela muscicola Kalb, Kalb: Lich. Neotr. Fasc. 10: 15 (1991).
ISOTYPE. Ecuador: Tungurahua, Südhang des Mt. Tungurahua, nördlich von Baños. Über Moosen in lückiger Vegetation. *K. & A. Kalb*, 16 August 1987 (CANL 102736). Kalb: Lich. Neotr. No. 447.

Tephromela nashii Kalb, Kalb: Lich. Neotr. Fasc. 12: 16 (1991).
ISOTYPE. Mexico: Baja California, 10 km N El Rosario in Cañon del Rosario. On small pebbles. *K. & A. Kalb & T. Nash*, 28 December 1990 (CANL 103794). Kalb: Lich. Neotr. No. 523.

Tephromela septentrionalis Hertel & Rambold, Bot. Jahrb. Syst. 107: 495 (1985).
ISOTYPE. Greenland: W-Grönland, Gemeinde Umanak. Über eisenreichem Silikatgestein. *J. Poelt & H. Ullrich*, August 1983 (CANL 95897). Hertel: Lecideaceae Exs. No. 178.

Tephromela tropica Kalb, Kalb: Lich. Neotr. Fasc. 10: 15 (1988).
ISOTYPE. Kenya: Central Province, Nanyuki District, zwischen Naco Moru und Nanyuki. *K. Kalb & A. Schrögl*, 18 August 1985 (CANL 102737). Kalb: Lich. Neotr. No. 448.

Tephromela velloziae Kalb, Kalb: Lich. Neotr. Fasc. 8: 16 (1984).
ISOTYPE. Brazil: Bahiz, Chapada Diamantina, Serra do Tombador, etwa 1 km vor der Stadt Morro do Chapeú. *K. Kalb*, 18-20 July 1980 (CANL 89464). Kalb: Lich. Neotr. No. 349.

Thelotrema brasiliana Hale in Kalb, Kalb: Lich. Neotr. Fasc. 7: 15 (1983).
ISOPARATYPE. Brazil: São Paulo, Ilha de São Sebastião, etwa 130 km östlich von São Paulo. Westhang des Morro das Tacas. In einem sehr feuchten und dunklen Regenwald an einem Fluss. *K. Kalb*, 6 July 1979 (CANL 85936). Kalb: Lich. Neotr. No. 298.

Toninia arctica Timdal, Opera Bot. 110: 37 (1991).
HOLOTYPE. Canada: Northwest Territories, Franklin District, Banks Island. *G.W. Scotter 30146*, 21-24 July 1979 (CANL 78540).
ISOTYPE. (CANL 78541).

PARATYPE. Canada: Yukon. *G.W. Scotter 19501* (CANL 54403).

Toninia ruginosa var. **andicola** Lamb, Rhodora 56: 147 (1954).
HOLOTYPE. Argentina: Prov. Catamarca, Nevados de Anconquija, Quebrada de los Cazadores. On soil. *I.M. Lamb 5599*, 24 November 1948 (CANL 6086).
= T. bullata (Meyen & Flotow) Zahlbr.

Toninia ruginosa subsp. **pacifica** Timdal, Opera Bot. 110: 90 (1991).
ISOTYPE. United States: California, Santa Barbara Co., Channel Islands, Santa Cruz Island, West end of the island. On the rim of the "Trailer Barranca", in rock crevices. *W.A. Weber & C. Bratt*, 8 January 1986. (CANL 97962). Weber: Lich. Exs. Colo. No. 663.

Toninia tristis subsp. **canadensis** Timdal, Opera Bot. 110: 113 (1991).
HOLOTYPE. Canada: Northwest Territories, District of Mackenzie, Dolomite Lake. *G.W. Scotter 6097*, 6 August 1965 (CANL 41669).
PARATYPES. Canada: British Columbia. *I.M. Brodo 21333* (CANL 86793); Northwest Territories. *G.W. Scotter 8283 & 8807* (CANL 43173 & 41670).

Toninia tristis subsp. **pseudotabacina** Timdal, Opera Bot. 110: 113 (1991).
PARATYPES. Cyprus: Larnaca. *A. Vězda* (CANL 99203). Vězda: Lich. Sel. Exs. No. 2262; Spain: Prov. Larida. *J. Poelt & A. Vězda* (CANL 89203).

Trapeliopsis hainanensis Hertel, Herzogia 5 (3-4): 460 (1981).
ISOTYPE. China: Prov. Guangdong, Insel Hainan. Bergwald-Schutzgebiet im Gebirge Jian Fung Ling im Kreise Ledong. *H. Hertel*, 23 May 1980 (CANL 77212). Hertel: Lecideaceae Exs. No. 59.

Trapeliopsis pseudogranulosa Coppins & P. James, Lichenologist 16: 259 (1984).
ISOTYPE. Canada: British Columbia, Vancouver Island, MacMillan Provincial Park on Rt. No. 4, 8 miles E of Alberni. On *Pseudotsuga*. *I.M. Brodo 7947*, 5 June 1966 (CANL 53995). Brodo: Lich. Canad. Exs. No 129.

Umbilicaria lambii Imsh., Bryologist 60: 232 (1957).
HOLOTYPE. Canada: British Columbia, Mt. Assiniboine Provincial Park, Sunburst Lake. On a large rock. *I.M. Lamb 6584*, 3 August 1951 (CANL 66543).

Umbilicaria phaea Tuck., Lich. Calif. p. 15 (1866).
ISOTYPE. United States: California. On rocks of Pacific Coast. *H.N. Bolander 11*, 1866 (CANL 68767). Reliq. Tuck. No. 94.

Usnea acromelana Stirton, Trans. & Proc. New Zealand Inst.

30: 388 (1897).
ISOTYPE. New Zealand: Christchurch, Canterbury, Selwyn Gorge. "On trees" (saxicolous!). *T.W.N. Beckett L.11*, May 1894 (CANL 16943).

Usnea durietzii Mot., Lich. Gen. Usnea Stud. Monogr., Pars System. II: 503 (1937)
ISOTYPE. Chile: Regio Magellanica, Insula Elisabetha. Ad saxa erratica granitica. *Lechler* (CANL 17098).

Usnea eulychniae Follm., Nova Hedwigia 14: 261 (1967)
ISOTYPE. Chile: Prov. Antofagasta, zerstreut im Dornenwerk von Säulenkakteen im *Tornabenietum intricatae*. *I.A. Follmann-Schrag* & *G. Follmann*, September 1965 (CANL 64294). Follmann: Lich. Exs. Sel. No. 60.

Usnea kuehnemanrii Mot. ex Lamb, Farlowia 4: 467 (1955).
ISOTYPE. Argentina: Patagonia, Prov. Neuquén, Parque Nacional Lanín, Lago Quillen. O. *Kuhnemann 796*, 1943 (CANL 104552).

Usnea neoguineensis Asah., J. Jap. Bot. 43: 496 (1968).
ISOTYPE. Papua New Guinea: Morobe District, Middle Creek logging area, Bullolo. *S. Kurokawa 5787*, 11-12 November 1965 (CANL 34214). Kurokawa: Lich. Rar. Crit. Exs. No. 149.

Usnea neuropogonoides Mot., Lich. Gen. Usnea Stud. Monogr., pars System. I: 73 (1936).
ISOTYPE. Argentina: Río Fosiles, in rupibus. *P. Dusén*, April 1905 (CANL 17188).

Usnea nidularis Asah., J. Jap. Bot. 44: 3 (1969).
ISOTYPE. Japan: Honshu, Prov. Iwaki, Matsukawa-ura, Sohma-gun. On *Pinus thunbergii*. *S. Kurokawa 58098-b*, 18 July 1958 (CANL 65983). Kurokawa: Lich. Rar. Crit. Exs. No. 346.

Usnea pseudoceratina Mot., Folia Geobot. Phytotax. 10: 326 (1975).
ISOTYPE. Tanzania: Southern Highlands, Poroto Mountains, NW end of Kitulo/Elton/Plateau. *T. Pócs 6750/G,* 10 August 1972 (CANL 57344).

Usnea tanzanica Mot., Folia Geobot. Phytotax., Praha 10: 327 (1975).
ISOTYPE. Tanzania: Prov. Mbeya, in monte ignivomo Rungwe. Ad ramulos arborum in regione subalpina. *T. Pócs 6507*, 21 January 1972 (CANL 57292). Vězda: Lich. Sel. Exs. No. 1322.

Verrucaria bagliettoi Servít, Ann. Mus. Civico Storia Nat. Giacomo Doria 64: 53 (1950).
ISOTYPE. Italy: Genova, Val Bisagno, Rupicola loco Fullo. *Sbarbaro*, November 1950 (CANL 692).

Verrucaria bisagnoensis Servít, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy. 9: 16 (1949).
ISOTYPE. Italy: Genova, Val Bisagno, Prato. *Sbarbaro*, April 1949 (CANL 693).

Verrucaria boccana Servít, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy. 9: 17 (1949).
ISOTYPE. Italy: Dalmatia meridionalis, Hercegnovi 40 m, silic. *M. Servít*, 1929 (CANL 694).

Verrucaria contardinis Servít, Ann. Mus. Civico Storia Nat. Giacomo Doria 66: 236 (1953).
ISOTYPE. Italy: Friuli, Zomeais, prope Tarcento. *A. Contardo*, 25 December 1951 (CANL 711).

Verrucaria diplotommoides Servít, Preslia 24: 355 (1952).
ISOTYPE. Italy: Genova, Staglieno. *Sbarbaro*, 30 March 1951 (CANL 718).

Verrucaria durietzii Lamb, Lilloa 14: 205 (1948).
HOLOTYPE. New Zealand: Auckland Islands, Port Ross, innermost small peninsula in Laurie Harbour. *G.E. Du Rietz 2225 b:1,* 27 March 1927 (CANL 721).
PARATYPE. New Zealand. *G.E.* & *G. Du Rietz 2070:2* (CANL 724).

Verrucaria durietzii f. **rhabdota** Lamb, Lilloa 14: 206 (1948).
HOLOTYPE. New Zealand: E. Falkland Islands, Berkeley Sound, Port Louis. On seashore rocks. *I.M. Lamb 2939*, 9 February 1946 (CANL 720).
PARATYPE. New Zealand. *I.M. Lamb 2877*, 29 January 1946 (CANL 723).

Verrucaria fuscella f. **omblensis** Servít, Stud. Bot. Čech. 7: 59 (1946).
ISOTYPE. Italy: Dalmatia, Ragusa, Ombla, Gionchello. *Latzel 104*, 1908 (CANL 802).
= V. omblensis (Servít) Servít

Verrucaria gorzegnoensis Servít, Webbia 8: 413 (1952).
ISOTYPE. Italy: Cuneo, Gorzehno, le Langhe. *Sbarbaro*, September 1951 (CANL 744).

Verrucaria haeyrenii ("häyrénii") Erichsen, Memoranda Soc. Fauna Fl. Fenn. 12: 5 (1937).
ISOTYPE. Finland: Nyland, Ekenäs, Tvärminne, Långskär. *E. Häyrén* & *C.F.E. Erichsen*, 29 June 1933 (CANL 747).

Verrucaria imperfecta Servít, Preslia 24: 359 (1952).
ISOTYPE. Italy: Genova, Val Risagno, Ligorna. *Sbarbaro*, 21 September 1950 (CANL 749).

Verrucaria incompta Sersít, Ann. Mus. Civico Storia Nat. Giacomo Doria 66: 237 (1953).
ISOTYPE. Italy: Savona, Spotorno, Rupicola loco Lajolo. *Sbarbaro*, January 1952 (CANL 752).

Verrucaria lacustris Lamb, Farlowia 4: 424 (1955).
HOLOTYPE. Argentina: Patagonia, Prov. Chubut, Lago Verde near Futalaufquen. On stone. *I.M. Lamb 5884*, 1 February 1950 (CANL 760).

Verrucaria langhensis Servít, Ann. Mus. Civico Storia Nat. Giacomo Doria 64: 48 (1950).
ISOTYPE. Italy: Gorzegno, Le Langhe, Piemonte. *Sbarbaro*, September 1947 (CANL 764).

Verrucaria latebrosoides Servít, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy. 9: 31 (1949).
SYNTYPE. Italy: Genova, Val Bisagno, Ligorna. *Sbarbaro*, 23 March 1950 (CANL 766).

Verrucaria ornata Servít, Stud. Bot. Čech. 11: 119 (1950).
ISOTYPE. Italy: Genova, Mt. Fasce. *Sbarbaro*, 1947 (CANL 803).

Verrucaria pseudomacrostoma Servít, Webbia 8: 415 (1952).
ISOTYPE. Italy: Cuneo, Langhe, Gorregno, 400 mt. Cortemilia. *Sbarbaro*, September 1951 (CANL 809).

Verrucaria putnae Servít, Preslia 24: 374 (1952).
ISOTYPE. Romania: Putna, Sovejanka. *Cretzoiu*, 1935 (CANL 813).

Verrucaria rapallensis Servít, Stud. Bot. Čech. 11: 121 (1950).
ISOTYPE. Italy: Genova, Rapalleo, Montallegro 500 mt. rupicola. *Sbarbaro*, October 1949 (CANL 814).

Verrucaria santensis Nyl., Acta Soc. Sci. Fenn. 7: 489 (1863).
ISOLECTOTYPE. United States: South Carolina, Santee Canal. *H.W. Ravenel*, 1850 (CANL 23286).
= Pyrenula santensis (Nyl.) Müll. Arg.

Verrucaria savonensis Servít, Webbia 8: 416 (1952).
ISOTYPE. Italy: Savona, Albisola marina, loco Seitun. *Sbarbaro*, August 1951 (CANL 822).

Vězdaea rheocarpa Poelt & Döbbeler, Bot. Jahrb. Syst. 96: 347 (1975).
ISOTYPE. Austria: südliches Burgenland. Über verschiedenen Moosen. *J. Poelt* & *P. Döbbeler*, 17 March 1974 (CANL 63545). Poelt: Lich. Alpium No. 293.

Wawea fruticulosa Henssen & Kantvilas, Lichenologist 17: 86 (1985).
ISOTYPE. Australia: Tasmania, Cradle Mountain National Park. On burned trunk of *Nothofagus cunninghamii*. *W.A. Weber* & *D. McVean*, 22 February 1968 (CANL 52202). Weber: Lich. Exs. Colo. No. 452.

Xanthoparmelia cylindriloba Knox, J. South African Bot. 49: 147 (1983).
ISOTYPE. Kenya: Regio montis Kenya, in parte superiore vallis Teleki. Ad terram glacie destructam. *O. Hedberg*, 27 July 1948 (CANL 93769). Vězda: Lich. Sel. Exs. No. 2063.

Xanthoparmelia lipochlorochroa Hale & Elix, Mycotaxon 34: 551

(1989).
ISOTYPE. United States: Wyoming, Lincoln Co., 15 mi. S of Kemmerer, Red Desert area. On sandy soil. *B.J. Buckingham S 22155*, 26 August 1959 (CANL 20819). Weber: Lich. Exs. Colo. No. 29.

Xanthoparmelia mollis Hale, Mycotaxon 27: 585 (1986).
ISOTYPE. South Africa: Natal. Port Shepstone District, Oribi Gorge Nature Reserve. On exposed sandstone outcrops. *M.E. Hale 74043*, 3 February 1986 (CANL 99574). Almborn: Lich. Africani No. 123.

Xanthopeltis rupicola R. Sant., Svensk Bot. Tidskr. 43: 560 (1949).
ISOTYPE. Chile: Prov. Santiago, San José. On rocks. *R. Santesson 2420*, 12 June 1940 (CANL 18087).

Xanthoria filsonii Elix, Elix: Lich. Austral. Exs. Fasc. 7 No. 174 (1988).
ISOTYPE. Australia: Victoria, Hopetoun, Patchewollock Road, 5 km NE of Hopetoun. On *Rhagodia*. *J.A. Curnow* & *H. Lepp 1422*, 14 March 1987. (CANL 98903). Elix: Lich. Austral. Exs. No. 174.

Xanthoria polycarpa var. **maritima** Lamb, Rep. (Annual) Natl. Mus. Canada, 1952-53. Bull. 132: 308 (1954).
HOLOTYPE. Canada: Nova Scotia, Victoria Co., Cape Breton Island, Ingonish, Middle Head. On granite rocks. *I.M. Lamb 6952*, 29 July 1952 (CANL 18084).

Zahlbrucknerella patagonica Henssen, Lichenologist 9: 41 (1977).
ISOTYPE. Argentina: Prov. Santa Cruz, Lago Argentino, Calafate, Cuevas de Hualichu. Sickerwasserflächen auf Schieferfels in Ufernähe. *A. Henssen* & *G. Vobis 24525a*, 18 December 1973 (CANL 102535). Henssen: Lich. Cyanoph. Fungi Sax. Exs. No. 30.
ISOPARATYPE. Argentina. *I.M. Lamb 5858 p.p.* (CANL 27339).

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REFERENCES

Bridson, G.D.R., 1991. Botanico-Periodicum-Huntianum/Supplementum. Carnegie-Mellon University, Pittsburgh.

Egan, R.S., 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the Continental United Stated and Canada. Bryologist **90**: 77-173.

Egan, R.S., 1989. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition I. Bryologist **92**: 68-72.

Egan, R.S., 1990. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United Stated and Canada." Edition II. Bryologist **93**: 211-219.

Egan, R.S., 1991. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition III. Bryologist **94**: 396-400.

MYCOTAXON

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NEOSARTORYA PRIMULINA, A NEW SPECIES OF FOOD-BORNE ASCOMYCETES

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ABSTRACT

A new species of *Neosartorya*, *N. primulina* Udagawa, Toyazaki et Tsubouchi, isolated from a canned oolong tea beverage in Japan, is described and illustrated. This fungus is characterized by its restricted growth on Czapek agar, chalky-buff ascomata, and lenticular ascospores with a very irregular ornamentation composed of several narrow crests and verrucose hemispheres.

Recently some widely-distributed species of *Neosartorya* have been incriminated as spoilage agents in commercially processed fruit products (Kavanagh et al., 1963; Beuchat, 1986; Conner and Beuchat, 1987; Scott and Bernard, 1987; Gomez et al., 1989; Nielsen et al., 1989; Samson, 1989; Splittstoesser and Churey, 1989; Samson et al., 1992). In an earlier paper (Udagawa et al., 1991), *Neosartorya hiratsukae* Udagawa, Tsubouchi et Horie was reported as the new causal agent of spoilage of pasteurized aloe beverage in Japan. A variety of commercial pasteurized beverages which were undergoing spoilage were selectively surveyed for further isolation of heat resistants. Pasteurized beverages (packaged in cans) by commercial processors for fungal isolation. Fungal mycelia were removed from the beverage by straining through a sterile membrane filter by aseptically transferred to chloramphenicol (100 µg/l)-potato dextrose agar.

During the course of this survey, several heat resistant fungi were encountered. Among them one isolate representing a hitherto undescribed species of *Neosartorya* (Malloch and Cain, 1972; Kozakiewicz, 1989; Peterson,1992) was found which is herein described and illustrated.

Neosartorya primulina Udagawa, Toyazaki et Tsubouchi, sp. nov. (Figs. 1, 2)

St. Anam. *Aspergillus primulinus* Udagawa, Toyazaki et Tsubouchi, anam. sp. nov.

Coloniae in agaro Czapekii paulo restrictae, aliquantum floccosae, plus minusve radiatim sulcatae, laxae, flavo-albae; conidiogenesis sparsa; reversum incoloratum vel pallide flavum. Coloniae in "Czapek yeast extract agar (CYA)" celeriter crescentes, velutinae, conspicue sulcatae, saepe zonatae, ex coacto mycelio basali tenuiter constantes, numerosis ascomatibus formantes, granulares, flavo-albae vel pallide flavae vel primulinae; conidiogenesis varians, viridi-grisea vel avellanea; reversum pallide flavum vel rubro-brunneum vel brunneo-aurantiacum. Coloniae in agaro maltoso effusae, floccosae, parum zonatae, tenues, laxae, abundantibus ascomatibus formantes, pallide flavae; conidiogenesis inconspicua; reversum incoloratum vel pallide flavum.

Ascomata non-ostiolata, superficialia, dispersa, cretacea vel bubalina, globosa vel subglobosa, 100-250 µm diam, hyphis brunneis laxe intricatis circumdata, lente maturescentia; peridium membranaceum, "textura epidermoidea" et "textura angularis"; stratum externum ex cellulis brunneis, irregularibus, incrassatis, 5-7.5 µm latis compositum. Asci octospori, brevi-catenati, subglobosi vel plus minusve pyriformes, 12-15(-17.5) x 11-13(-15) µm, evanescentes. Ascosporae hyalinae, lenticulares, sine cristis 4.5-5(-5.5) x 3.8-5 µm, cristis numerosis angustatis irregulatim ornatae.

Capitula conidica parva, brunneo-grisea, laxe radiantia; conidiophora ex mycelio basali vel interdum hyphis aeriis ascendentes; stipites brunneoli, 200-600 x 2.5-5 (-6) µm, leves et incrassati, saepe septati; vesiculae brunneae, ampulliformes, 7.5-16 µm diam. Aspergilla uniserialia; phialides cylindricae, 5-7.5 x 2-2.5 µm, in sum-

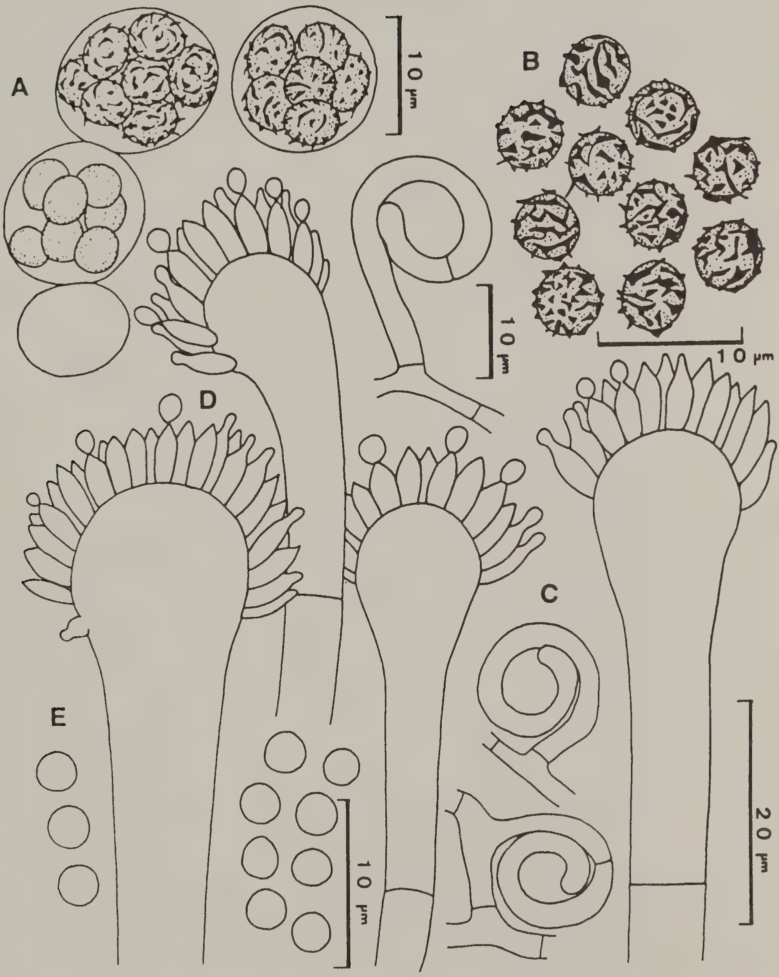

A
B
C
D
E
10 µm
10 µm
10 µm
10 µm
20 µm

Figure 1. *Neosartorya primulina*, SUM 3014.
A. Asci. B. Ascospores. C. Ascomatal initials.
D. Aspergilla. E. Conidia.

ma 1/2-2/3 vesicula insidentes. Conidia hyalina, globosa vel subglobosa vel parum ovoidea, 2-3(-4.5) x 2-2.5 µm, levia.

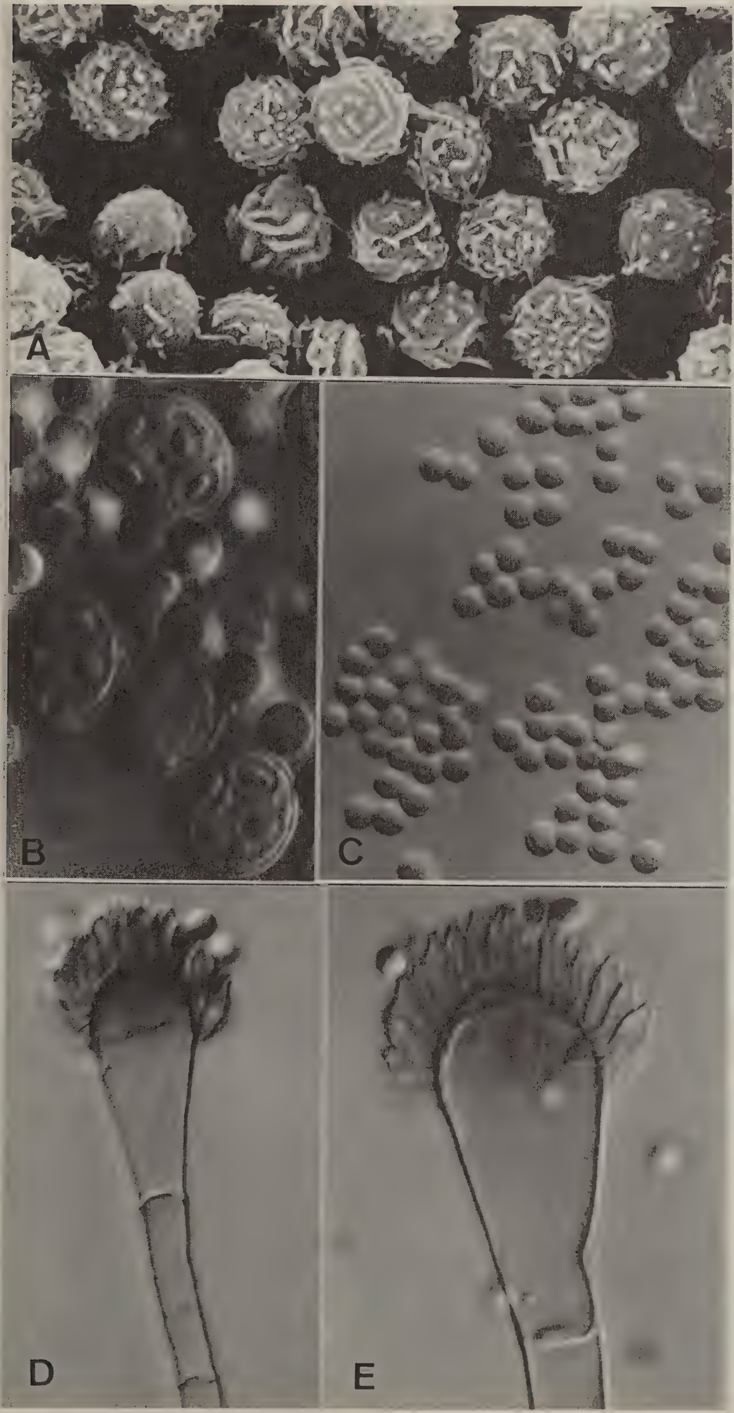
Holotypus SUM 3014, colonia exsiccata in cultura ex aqua decocta thea, Okinawa in Japonia, 22.vii.1991, isolata et ea in collectione fungorum Musei et Instituti Historiae Naturalis Chiba (CBM) conservata.

Etymology: from Latin, *primulinus*=primrose, referring to the colony color.

Colonies on Czapek agar growing rather restrictedly, attaining a diameter of 27 mm within 7 days at 25°C, somewhat floccose, more or less furrowed in a radial pattern, loose-textured, yellowish white (M. 4A2 after Kornerup and Wanscher, 1978); conidiogenesis sparse, inconspicuous; reverse uncolored to pale yellow (M. 4A3) or Straw (Rayner, 1970). Colonies on CYA growing rapidly, attaining a diameter of 46 mm within 7 days at 25°C, or 85 mm within 7 days at 37°C, velvety, deeply furrowed, often zonate, consisting of a thin basal felt intermixed with numerous ascomata in a granular appearance at 25°C, yellowish white (M. 4A2) to pale yellow (M. 3A3-4A3) or Primrose (Rayner); conidiogenesis limited or profuse at 37°C, in the latter case greenish gray to brownish orange (M. 29D2-6C4) or Hazel (Rayner); reverse light yellow to reddish brown (M. 4A4-8E5) or Dark Brick (Rayner). Colonies on malt extract agar (MEA) spreading broadly, attaining a diameter of 54-56 mm within 7 days at 25°C, or 85 mm within 7 days at 37°C, floccose, plane or slightly zonate, thin, loose-textured, characterized by abundant ascomata in granular appearance, pale yellow (M. 4A3) or Buff (Rayner); conidiogenesis moderate at 37°C but not sufficiently produced to influence the colony appearance; reverse uncolored to pale yellow (M. 4A2-3) or Pale Luteous (Rayner).

Ascomata non-ostiolate, superficial, scattered, chalky to buff, globose to subglobose, 100-250 µm in diam, covered loosely with brownish encrusted hyphae, maturing within 21 days at 25°C; peridium 10-12.5 µm thick, membranaceous, textura epidermoidea, two-layered; outer layer composed of brownish, irregular-shaped, thick-walled cells measuring 5-7.5 µm wide; inner layer of hyaline, thin, flattened, angular cells measuring 6-12.5 x 4.5-7.5 µm.

Figure 2. *Neosartorya primulina*, SUM 3014.
A. Ascospores (SEM), x 2500. B. Asci, x 1300.
C. Conidia, x 1300. D, E. Aspergilla, x 1000 and x 1300, respectively.


A
B
C
D
E

Ascomatal initials developing as short branches of hyphae with large curled tips measuring ca. 12.5 µm in diam. Asci 8-spored, produced in short chains, subglobose to more or less pyriform, 12-15(-17.5) x 11-13(-15) µm, evanescent at maturity. Ascospores hyaline, lenticular, spore body 4.5-5(-5.5) x 3.8-5 µm, provided with several narrow crests measuring ca. 0.5 µm wide and with irregularly verrucose hemispheres. Conidial heads intermixed with ascomata, small, brownish gray, loosely radiate; conidiophores arising from the basal mycelium or sometimes from the aerial hyphae, stipes brownish, 200-600 x 2.5-5(-6) µm, smooth and thick-walled, often several times septate; vesicles brownish, flask-shaped, 7.5-16 µm in diam. Aspergilla uniseriate, phialides cylindric, 5-7.5 x 2-2.5 µm, covering the upper half to two-thirds of the vesicle. Conidia hyaline, globose to subglobose or slightly ovoidal, 2-3(-4.5) x 2-2.5 µm, smooth-walled. Maximum growth temperature: 47°C. Pasteurization at 82°C for 15 min is effective.

Specimen examined: SUM 3014 (holotype), a dried culture of an isolate from a canned oolong tea beverage, Okinawa-Pref., Japan, 22.vii.1991. The specimen studied and living culture derived from the type are preserved in the Natural History Museum and Institute, Chiba (CBM), Japan.

Neosartorya primulina can be readily recognized by its chalky-buff colored ascomata, short-stipitate initials of the ascomata, and morphology of the ascospores. The scanning electron micrograph (SEM) of the ascospores provided a much clearer differentiation between *N. primulina* and all other members of *Neosartorya* (Samson et al., 1990, 1992); the ascospore ornamentation in this species is characterized by several narrow crests in the equatorial area and irregularly verrucose hemispheres (Fig. 2). *Neosartorya hiratsukae* somewhat resembles this species in the restricted growth on Czapek agar and in the formation of pale yellow ascomata, but differs in having ascospores with convex walls bearing numerous closely anastomosing ridges arranged in a fine reticulate ornamentation(Udagawa et al.,1991).

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Literature cited

Beuchat, L. R. 1986. Extraordinary heat resistance of *Talaromyces flavus* and *Neosartorya fischeri* ascospores in fruit products. J. Food Sci., 51: 1506-1510.

Conner, D. E. and Beuchat, L. R. 1987. Heat resistance of ascospores of *Neosartorya fischeri* as affected by sporulation and heating medium. Intl. J. Food Microbiol., 4: 303-312.

Gomez, M. M., Busta, F. F. and Pflug, I. J. 1989. Effect of the post-dry heat treatment temperature on the recovery of ascospores of *Neosartorya fischeri*. Lett. Appl. Microbiol., 8: 59-62.

Kavanagh, J., Larchet, N. and Stuart, M. 1963. Occurrence of a heat resistant species of *Aspergillus* in canned strawberries. Nature (Lond.), 198: 1322.

Kornerup, A. and Wanscher, J. H. 1978. Methuen Handbook of Colour. 3rd ed. Eyre Methuen, London. 252p.

Kozakiewicz, Z. 1989. *Aspergillus* species on stored products. CMI Mycological Papers No. 161: 1-188.

Malloch, D. and Cain, R. F. 1972. The Trichocomataceae: Ascomycetes with *Aspergillus*, *Paecilomyces*, and *Penicillium* imperfect states. Can. J. Bot., 50: 2613-2628.

Nielsen, P. V., Beuchat, L. R. and Frisvad, J. C. 1989. Growth and fumitremorgin production by *Neosartorya fischeri* as affected by food preservatives and organic acids. J. Appl. Bacteriol., 66: 197-207.

Peterson, S. W. 1992. *Neosartorya pseudofischeri* sp. nov. and its relationship to other species in *Aspergillus* section *Fumigati*. Mycol. Res., 96: 547-554.

Rayner, R. W. 1970. A Mycological Colour Chart. Commonwealth Mycological Institute, Kew and the British Mycological Society.

Samson, R. A. 1989. Filamentous fungi in food and feed. J. Appl. Bacteriol. Symp. Suppl., 67: 27S-35S.

Samson, R. A., Nielsen, P. V. and Frisvad, J. C. 1990. The genus *Neosartorya*: Differentiation by scanning electron microscopy and mycotoxin profiles. In: Modern Concepts in *Penicillium* and *Aspergillus* Classification. Ed. Samson, R. A. and Pitt, J. I. Pp. 455-467. Plenum Press, New York.

Samson, R. A., Hocking, A. D., Pitt, J. I. and King, A. D. (ed.) 1992. Modern Methods in Food Mycology. Elsevier, Amsterdam. 388p.

Scott, V. N. and Bernard, D. T. 1987. Heat resistance of *Talaromyces flavus* and *Neosartorya fischeri* isolated from commercial fruit juices. J. Food Prot., 50: 18-20.

Splittstoesser, D. F. and Churey, J. J. 1989. Effect of low concentration of sorbic acid on the heat resistance and viable recovery of *Neosartorya fischeri* ascospores. J. Food Prot., 52: 821-822.

Udagawa, S., Tsubouchi, H. and Horie, Y. 1991. *Neosartorya hiratsukae*, a new species of food-borne Ascomycetes. Trans. Mycol. Soc. Japan, 32: 23-29.

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STUDIES ON BOLETUS SECTION LURIDI

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SUMMARY

Four species of Boletus section Luridi described by Smith and Thiers have been studied: Boletus pseudo-olivaceus, B. roseobadius, B. rufocinnamomeus, and B. subluridellus. B. pseudo-olivaceus can be easily differentiated from the other species by its weakly but distinctly amyloid trama in stipe and pileus. There are no major microscopical differences between B. subluridellus, B. rufocinnamomeus, and B. roseobadius.

INTRODUCTION

The section Luridi Fr. is a relatively well defined group in the genus Boletus Fr. Singer (1986) characterized the section by its Boletus habit, the narrow pores, which are often discolorous and red, and by the occasional presence of toxins in the fruitbodies. The sporocarps turn immediately blue on bruising or cutting. Smith and Thiers (1971), who interpreted the group as a subsection within the section Boletus, have increased our knowledge of the group considerably; they also described several new species from Michigan.

A recently found collection from Virginia revealed however, that species delimitation within this group is still problematic; a number of characters considered to be important for species delimitation showed variation within the collection. Smith and Thiers (1971) described a "spatter pattern" for the distribution of different characters within this group and suspected a gene exchange between some taxa, such as B. subvelutipes Peck and B. pseudo-olivaceus Smith and Thiers, two species growing in the same habitat. Therefore, a reevaluation of characters seems to be necessary. As a first step the collection from Virginia and specimens of four different species which are closely related have been studied here.

MATERIALS AND METHODS

Microscopical observations were made in KOH (10%) unless stated otherwise, but the cuticle was observed in Melzer's reagent. A drawing tube was used for the illustrations. At least 15 spores per collection were measured and the mean dimensions D^M for the spores were calculated; the length/width ratio (Q) was obtained for each of the spore measurements and a mean value (Q_m) was calculated for each of the species.

Detailed descriptions of the macroscopic characters of each taxon were presented by Smith and Thiers (1971).

Color descriptions follow Kornerup & Wanscher (1967). Official colors are in quotes.

The terminology of cystidia has been adopted from Singer (1986) and Wolfe (1991).

RESULTS

Boletus TR 1316
Figs. 21-25

Pileus 4-14 cm, convex, surface tomentose to almost velvety, color dark "olive brown" to "raw umber", "soot brown", or "coffee" (4 F4-8; 5 F5-8), a few fruitbodies with rose-red areas. **Tubes** adnexed, up to 1 cm thick, yellow, but rapidly staining blue when cut. **Pores** round, small, "lake red", "Pompeian red", "dark red" until old age (9 C7-8, 10 C7-8), staining greenish blue when injured. **Spore print** "bronze", "mustard brown", "linoleum brown" (5 E5-7).

Stipe clavate or equal, solid, 2.5-9 cm long, 1.5-3.5 cm thick, orange-yellow, dark red toward the base, bruising instantly blue. In some specimens a fine red reticulation was observed on the very tip of the stipe.

Context of the whole fruitbody after cutting instantly changing to dark blue.

Chemical reactions of (blued) pileus context: KOH orange; NH_4OH yellow, $FeSO_4$ yellow. Chemical reactions on pileus surface: KOH (-); NH_4OH (-); $FeSO_4$ (-).

Spores 10.8-13.5 x 3.6-5.4 μm; D^M = 12.1 x 4.4 μm; Q = 2.3-3.3; Q_m = 2.8; fusoid, yellow to brownish yellow in KOH; spores from deposit 11.7-14.4 x 3.6-5 μm, pale yellow-brown in KOH; spores in Melzer's reagent 10.4-12.6 x 3.6-4.5 μm, occasionally thick-walled, pale yellow-brown. **Basidia** 26-41 x 8-10 μm, 4-spored, occasionally 2-spored, no basal clamps, hyaline in KOH and Melzer's reagent, a few with a yellow, plasmatic pigment. **Pleurocystidia** 24-52 x 4.7-8 μm, fusiform. **Pseudocystidia** 19-31 x 3.7-5.8 μm, fusiform. All septa without clamps.

Cuticle a trichoderm or occasionally a cutis, 180-190 μm thick; trichodermial end cells connected at their tips and forming fascicles. Trichodermial hyphae 3.5-4.1 μm thick, with deep red walls and occasionally brown contents in Melzer's reagent; yellowish, pigment plasmatic, sometimes with granular contents in KOH. Context below trichoderm a tangle of hyaline hyphae, 3.5-5.9 μm thick, with granular, yellow-brown debris between hyphae; occasionally some hyphae have peculiar wall thickenings up to 1.5 μm. Oleiferous hyphae can be found occasionally (diam. 5 μm).

Stipe dermatocystidia of two types: first type 21-26 x 4.2-7.4 μm clavate, similar to probasidia. Second type (less frequent) 19-110 x 4.1-8 μm, fusiform. Scattered basidia can be found all along the stipe cortex, 23-35 x 8-10 μm, 2- or 4-spored, with yellow content in KOH, yellow-brown to dark brown in Melzer's reagent. Tramal hyphae inamyloid.

Comments. This collection seems to be close to B. subluridellus although the Q_m value for the spores is somewhat higher for this collection (2.8 here versus 2.6 in the holotype of B. subluridellus). A number of characters shows high variation within the collection:

The long and setiform caulocystidia which were regarded by Smith and Thiers (1971) as an important character to delimit the group around B. subluridellus could be found only sporadically in some but not all fruitbodies of this collection. Therefore their presence seems to vary within at least this species.

The structure of the cuticle is also variable: usually it consists of conical fascicles of trichodermial hyphae but in the same collection it can be a cutis.

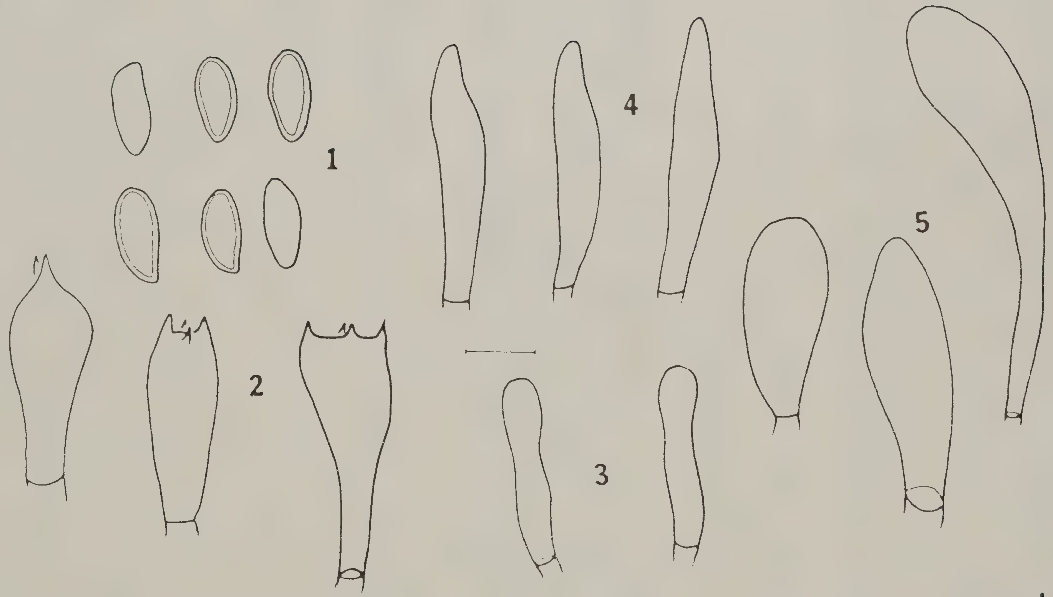
Collection examined:
Virginia, Montgomery Co., near Pandapas Pond, under oak and white pine, 9 Aug 1991, R. Treu (TR 1316), Massey Herbarium (VPI).

Boletus pseudo-olivaceus Smith & Thiers. 1971. The boletes of Michigan. P. 353.
Figs. 1-5

Spores 12.2-15.3 x 5.4-6.3 μm; D^M = 14.1 x 5.9 μm; Q = 2.3-2.8; Q_m = 2.4; fusoid, often thick-walled (0.5-1 μm), in KOH yellow; spores in Melzer's reagent 9.9-15.3 x 5-5.9 μm, thick-walled (0.5-1 μm), pale brownish yellow. In Melzer's reagent many spores show a minute, indistinct germ pore. **Basidia** 31-39 x 9-13 μm, four-spored or two-spored, hyaline or yellow. **Pleurocystidia** 37-41 x 6-7 μm, fusiform. **Pseudocystidia** 26-29 x 6-7 μm, clavate, with golden yellow pigmentation (plasmatic). All septa without clamps.

Cuticle a cutis, 350-450 μm thick, with many oleiferous hyphae; hyphae 2.3-6.3 μm thick, hyphal walls not red in Melzer's reagent; oleiferous hyphae with yellow, homogeneous content.

Stipe dermatocystidia 29-63 x 12-14 μm, fusiform or



Figs. 1-5 Boletus pseudo-olivaceus. 1 Spores. 2 Basidia. 3 Pseudocystidia. 4 Pleurocystidia. 5 Stipe dermatocystidia. Scale bars = 10μm.

clavate, yellow or brownish yellow. Occasionally yellow caulobasidia can be found among the cystidia. Tramal hyphae of stipe as well as tramal hyphae of pileus slightly amyloid, purple to grayish in Melzer's reagent. Yellow-orange tomentum at the base of the stipe consisting of bundles of parallel hyphae, 1.8-3.6 µm thick, yellowish in KOH, brownish and some hyphae with dark brown contents in Melzer's reagent.

Comments. *B. pseudo-olivaceus* is easily distinguished from the other species by a weak, but distinct amyloid reaction of the hyphae in both the pileus and the stipe trama. This reaction is persistent and should not be confused with the "fleeting-amyloid" reaction described by Smith and Thiers (1971) for some boletes. The spores of *B. pseudo-olivaceus* also have a lower Q_m value (2.4) than the other species (2.6-2.7).

Collections examined:

Michigan, Emmet Co., Mackinaw City Hardwoods, scattered at edge of hardwood forest, 12 Jul 1967, A.H. Smith 74510 - holotype, MICH.

Michigan, Charlevoix Co., East Jordan, 12 Jul 1967, James Bennet (A.H. Smith 74511), MICH.

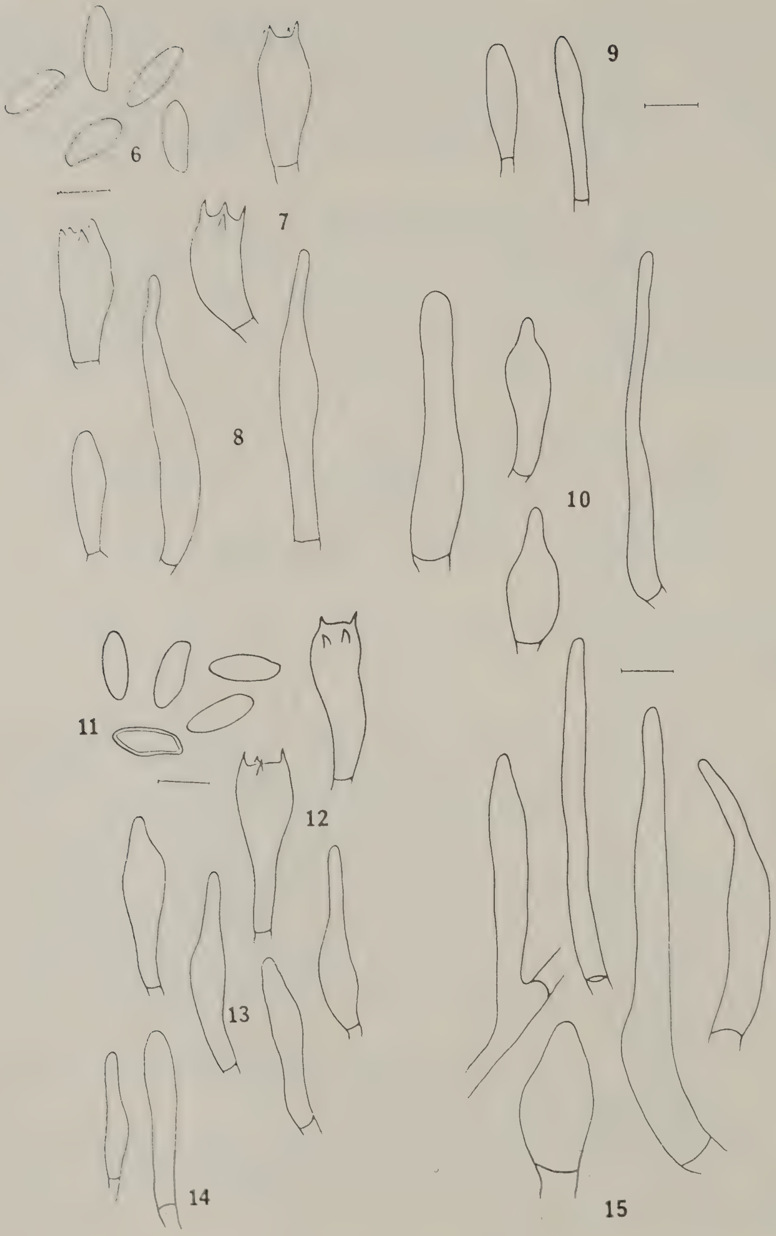
Boletus roseobadius Smith & Thiers. 1971. The boletes of Michigan. P. 354.
Figs. 6-10

Spores 13.1-16.2 x 4.5-6.3 µm; D^M = 14.5 x 5.5 µm; Q = 2.4-3; Q_m = 2.7; fusoid, sometimes thick-walled, yellowish-brown to yellow in KOH; spores in Melzer's reagent 12.2-16.7 x 4.5-6.3 µm, yellowish-brown to brown. Spores on the stipe cortex sometimes dextrinoid and broader than hymenial spores. **Basidia** 25-34 x 8-12 µm, four-spored or two-spored, hyaline or sometimes with yellow, homogenous or granular, plasmatic pigment. **Pleurocystidia** 24-62 x 6-10 µm, fusiform, mostly with apical neck. **Pseudocystidia** 21-34 x 5-6 µm, fusiform or clavate, with golden yellow pigmentation (plasmatic), along the tube edges; occasionally a few pseudocystidia with size and shape of the pleurocystidia, but with yellow pigment, on the tube walls. All septa without clamps.

Cuticle a cutis, 130-230 µm thick; hyphae 2.7-5.4 µm thick, hyphal walls red in Melzer's reagent; some hyphae with yellow, granular content.

Stipe dermatocystidia 24-80 x 5-11 µm, fusiform or cylindric sometimes with an apical neck, hyaline or brown. Occasionally 3- or 4-spored brown basidia can be found among the cystidia. Tramal hyphae inamyloid, in stipe base sometimes with red walls.

Comments. It is almost impossible to distinguish this



Figs. 6-10 Boletus roseobadius. 6 Spores. 7 Basidia 8 Pleurocystidia. 9 Pseudocystidia. 10 Stipe dermatocystidia. Figs. 11-15 Boletus rufocinnamomeus. 11 Spores. 12 Basidia 13 Pleurocystidia. 14 Pseudocystidia. 15 Stipe dermatocystidia. Scale bars = 10μm.

species from B. subluridellus on microscopic characters. A very distinctive feature of these species is the deep red color of the walls of many cuticular hyphae in Melzer's reagent. Smith and Thiers (1971) characterized the species by the size of the pleurocystidia, the red (in Melzer's reagent) cuticular hyphae, and the brown cortex elements (in KOH). However, there is no differences in the size of the pleurocystidia (24-62 µm in B. roseobadius, 34-50 µm in B. subluridellus). Smith and Thiers (1971) described B. roseobadius as having a whitish or pallid flesh in comparison the bright yellow flesh in B. subluridellus. The interpretation of this feature might be difficult because of the instant color change of the flesh to deep blue.

Collections examined:

Michigan, Washtenaw Co., solitary under low hardwoods, 20 Sep 1965, F. V. Hoseney (A.H. Smith 72668 - holotype), MICH.

Michigan, Washtenaw Co., Pinckney State Recreation Area, 25 Aug 1973, A.H. Smith 84537, MICH.

Boletus rufocinnamomeus Smith & Thiers. 1971. The boletes of Michigan. P. 356.
Figs. 11-15

Spores 13.2-16.2 x 5.1-6.3 µm; D^M = 14.4 x 5.4 µm; Q = 2.4-3 ; Q_m = 2.7; fusoid, mostly thin-walled, pale to golden yellow; spores in Melzer's reagent 12.6-17.1 x 4.5-6.3 µm, yellowish brown. **Basidia** 30-34 x 10-12 µm, four-spored, occasionally two-spored, hyaline. **Pleurocystidia** 24-40 x 5-9 µm, fusiform with apical neck. **Pseudocystidia** 25-34 x 4-6 µm, fusiform, sometimes with a neck, with golden yellow pigmentation (plasmatic), along the tube edges, sometimes a few on the tube walls. All septa without clamps.

Cuticle a trichodermium, 180-200 µm thick, formed of conical fascicles of trichodermial hyphae with brown, often granular content in Melzer's reagent; occasionally some of the hyphae below the fascicles with weakly red walls in Melzer's reagent. Hyphae forming the fascicles 1.8-3.6 µm thick, hyphae below 2.7-6.3 µm.

Stipe dermatocystidia 24-100 x 4-14 µm, fusiform, with or without a neck, occasionally with a secondary septum, hyaline or golden yellow or brownish. Tramal hyphae inamyloid.

Collections examined:

Michigan, Cheboygan Co., Burt Lake, hardwoods, 11 Aug 1969, A.H. Smith 77831 - holotype, MICH.

Michigan, Cheboygan Co., Burt Lake, Colonial Point Hardwoods, 7 Aug 1969, A.H. Smith 77746, MICH.

Boletus subluridellus Smith & Thiers. 1971. The boletes of Michigan. P. 349.
Figs. 16-20

Spores 10.6-15.3 x 4.5-5.4 µm; D^M = 12.8 x 4.9 µm; Q = 2.2-2.9; Q_m = 2.6; fusoid, occasionally slightly thick-walled, brownish yellow in KOH; spores in Melzer's reagent 11.7-14.4 x 4.5-5.9 µm, yellow-brown. Spores on stipe cortex frequently with golden yellow pigmentation. **Basidia** 22-36 x 11-12 µm, 4-spored, hyaline, yellow-brown or brown. **Pleurocystidia** 34-50 x 6-8 µm, fusiform with apical neck or clavate-mucronate. **Pseudocystidia** 32-33 x 4-6 µm, fusiform and sometimes with apical neck or clavate, with golden yellow pigmentation (plasmatic), along the tube edges; occasionally a few pseudocystidia with size and shape of the pleurocystidia, but with yellow pigment, on the tube walls. All septa without clamps.

Cuticle a trichodermium formed of conical fascicles of hyphae; thickness of cuticle 180 µm; diameter of trichodermial hyphae 3.5-5 µm, hyphal walls deep red in Melzer's reagent.

Stipe dermatocystidia variable, fusiform, with or without a neck, or broadly clavate-mucronate; fusiform cystidia 26-66(89) x (3)5-13 µm; clavate-mucronate cystidia 30-35 x 14-18 µm; hyaline or golden yellow in KOH, brown in Melzer's reagent. Tramal hyphae inamyloid.

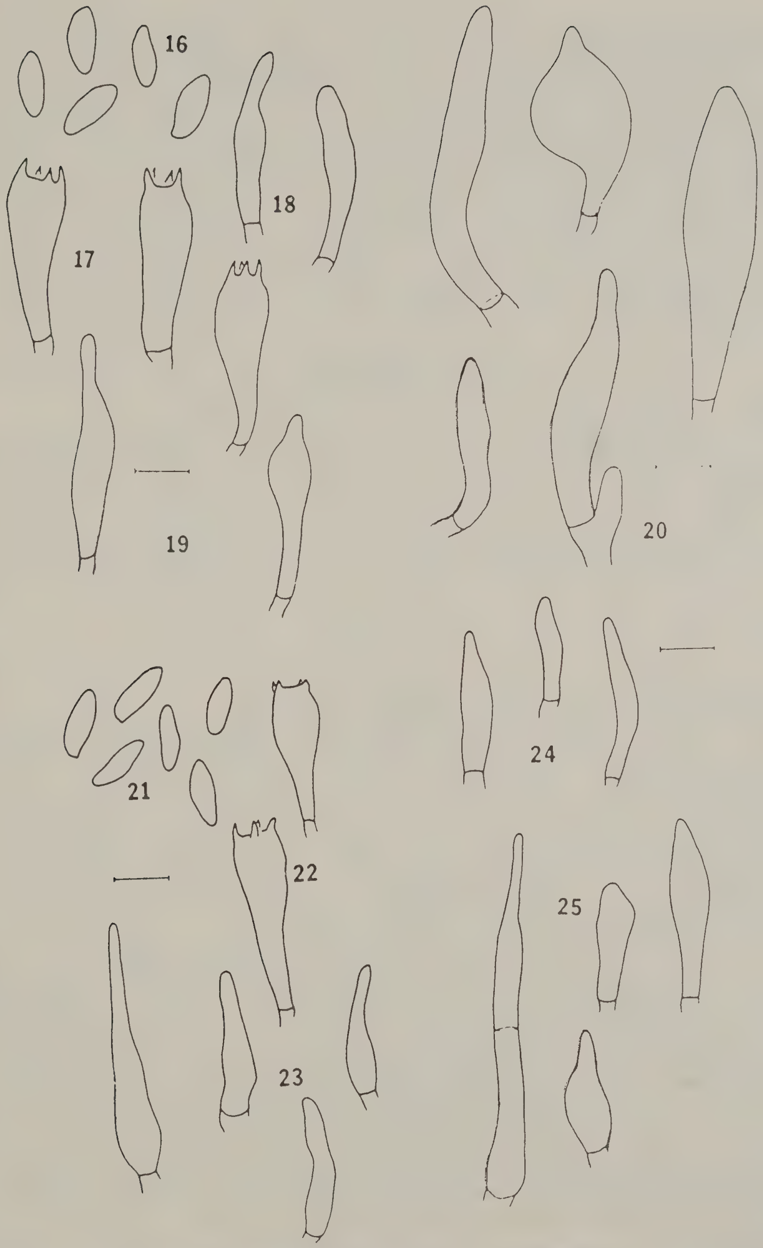
Comments: see B. roseobadius

Collection examined:
Michigan, Washtenaw Co., Ypsilanti Golf Course, Ypsilanti, in grassy oak woods, 3 Sep 1961, A.H. Smith 64046 - holotype, MICH.

DISCUSSION

There is not much variation in the spore size of the different taxa studied here. However, the Q and Q_m values are increasingly used as a taxonomic character (Breitenbach and Kränzlin 1991, Wolfe 1991). B. pseudo-olivaceus with a Q_m of 2.4 differs from the other species with a Q_m between 2.6 and 2.8.

The hymenial cystidia range in shape from usually fusiform to almost clavate. Fusiform cystidia often have an apical neck. Following the terms used by Singer (1986) and Wolfe (1991) for hymenial cystidia, most species have fusiform or clavate, yellow pseudocystidia along the tube edges and hyaline pleurocystidia located on the tube walls and larger in size. Occasionally a few pseudocystidia can be found on the tube wall, and they differ from the pleurocystidia only in their yellow pigment. In contrast to the genus Tylopilus Karsten, where hymenial cystidia play an



Figs. 16-20 Boletus subluridellus. 16 Spores. 17 Basidia. 18 Pseudocystidia. 19 Pleurocystidia. 20 Stipe dermatocystidia. Figs. 21-25 Boletus (TR 1316). 21 Spores. 22 Basidia. 23 Pleurocystidia. 24 Pseudocystidia. 25 Stipe dermatocystidia. Scale bars = 10μm.

important role for the delimitation of species (e.g. Wolfe 1986, Wolfe 1991), the cystidia in the section *Luridi* do not seem to be important taxonomic characters.

Stipe dermatocystidia have been used by Smith and Thiers (1971) to delimit species in the section *Luridi* (*B*. *subluridellus*, *B*. *roseobadius*, and *B*. *rufocinnamomeus* with long, often setiform caulocystidia). Measurements taken here show however, that they can range widely within one collection and are often difficult to find, especially in small collections. Some sporocarps of collection TR 1316 had very long stipe dermatocystidia but these were scattered, difficult to detect and only present in some fruitbodies of the collection. The shape of the stipe dermatocystidia ranges from clavate to rostrate to fusiform and their contents often stain brown in Melzer's reagent.

Basidia do not show variation between the species. They are usually hyaline, but sometimes also pigmented. Their basal septum is simple, without clamps.

The hymenophoral trama in all the species studied is divergent, sometimes only slightly so, with a central strand of parallel hyphae which stains brownish in Melzer's reagent.

The cuticle can range from a trichoderm to a cutis. Larger collections (TR 1316) show that there is variation within species. The content of cuticle hyphae of *B*. *rufocinnamomeus* turns brownish in Melzer's reagent. The same character could occasionally be observed in the collection TR 1316.

In most cases the tips of trichodermial hyphae are glued together to form conical fascicles.

A very conspicuous character of both *B*. *subluridellus* and *B*. *roseobadius* are the cuticular hyphae many of which have deep red walls in Melzer's reagent. However, this constitutes no dextrinoidity, because the pigment can be observed in water mounts as well. It can not be detected in KOH, where it apparently changes its color or dissolves. Rarely those pigmented hyphae could also be detected in the cuticle of *B*. *rufocinnamomeus*. The pigment is often indicated macroscopically by a red color of parts of the fruitbody (e.g. pileus, stipe trama).

A peculiar character of *B*. *pseudo-olivaceus* is the amyloid trama of stipe and pileus. Although very distinctive, the intensity of the staining is not very strong and quite homogeneous throughout the trama. A stronger amyloid reaction in the genus *Boletus* can be found in cross walls of tramal hyphae of *Boletus* *calopus* Fr. (Miller and Watling 1968) and in *B*. *piedmontensis* Grand and Smith in the form of amyloid particles in the cuticular hyphae (Grand and Smith 1971). According to Smith and Thiers (1971) *B*. *pseudo-olivaceus* is closely related to *B*. *queletii* Schulz. from Europe, a view supported by Singer's (1977) observation of distinctly amyloid hyphae in the stipe of *B*. *queletii*.

None of the species shows clamps in any parts of the fruitbodies.

The collection TR 1316, which has been included in this study, seems to be close to or identical with B. subluridellus. The presence of many red-walled hyphae in the cutis and the spore measurements indicate a high similarity between the material from Virginia and collections of B. subluridellus. At the same time however, many characters, like the pigmentation of the cuticular hyphae, seem to vary even within collections of one species and may depend on the age of sporocarps. Larger collections may reveal the variability of some of the characters which are traditionally used. Therefore a further study of a larger number of other taxa in this group is obligatory and would necessarily include the European taxa of this group.

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LITERATURE

Breitenbach, J. and F. Kränzlin. 1991. Fungi of Switzerland. Vol. 3. Boletes and agarics. 1st part. Edition Mykologia, Lucerne, Switzerland.

Grand, L.F. and A.H. Smith. 1971. A new species of Boletus, section Luridi, from North Carolina. Mycologia 63: 884-888

Kornerup, A. and J.H. Wanscher. 1967. Methuen Handbook of Colour. Methuen and Co. Ltd., London, Great Britain.

Miller, O.K., Jr. and R. Watling. 1968. The status of Boletus calopus Fr. in North America. Notes from the Royal Botanic Garden Edinburgh 28: 317-325.

Singer, R. 1977. Keys for the identification of the species of Agaricales I. Sydowia 30: 192-279.

Singer, R. 1986. The Agaricales in modern taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein, Germany.

Smith, A.H. and H.D. Thiers. 1971. The boletes of Michigan. The University of Michigan Press, Ann Arbor, Michigan.

Wolfe, C.B., Jr. 1986. Type studies in Tylopilus. III. Taxa described by Walter H. Snell, Esther A. Dick, and co-workers. Mycologia 78: 22-31.

Wolfe, C.B., Jr. 1991. Type studies in Tylopilus (Boletaceae). V. Taxa described by Alexander H. Smith, Harry D. Thiers and Samuel J. Mazzer. Can. J. Bot. 69: 1833-1838.

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TWO NEW CRINIPELLINAE (TRICHOLOMATACEAE: MARASMIAE) FROM SOUTH AMERICA

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ABSTRACT

Crinipellis ticoi from lowland Bolivia and *Chaetocalathus magnus* from Andean Colombia are newly described from the Neotropics. Both taxa possess dextrinoid, long, thick-walled, setoid hairs on the pileus that distinguish these lamellate genera in the Crinipellinae.

Key Words: Agaricales, Crinipellinae, *Crinipellis*, *Chaetocalathus*, Bolivia, Colombia

Study of specimens gathered in South America over a four year period (1986-1990) has resulted in the discovery of many new taxa of agarics and boletes (*e.g.*, Halling & Ovrebo, 1987; Halling 1989a, 1989b, Singer *et al.*, 1990; Horak & Halling, 1991; Tulloss *et al.*, 1992; Baroni & Halling, 1992; Halling, 1992). Further observations on additional material has yielded a previously unknown species of *Crinipellis* with bright orange pigmentation and the largest species of *Chaetocalathus* known to date. Fifty years ago, Singer (1942) provided a worldwide monograph of these two genera, and more recently, published an updated monograph for the Neotropical taxa (Singer, 1976). Two additional Neotropical species (one from each genus) have since been recognized (Singer, 1989).

Color designations in parentheses (e.g., 5A6) are taken from Kornerup and Wanscher (1983). Other color terms (e.g. brick red) are general approximations of those designations. Letter abbreviations describing spore sizes are: n = number of spores measured, x = mean length × mean width, Q = mean length/width ratio.

Crinipellis ticoi Halling, sp. nov. Figs. 1–4

TYPE: BOLIVIA. Dpto. Beni: Prov. Iturralde, S of Rurrenabaque, Río Tuichi near junction with Río Beni, "Laguna del Tigre," ±67°30'W, 14°25'S, 14 Apr 1990, *Halling 6433* (Holotype: LPB; Isotype: NY).

Pileus aurantius sulcatus tomentosus vel subtomentosus, epilosus. Lamellae adnexae subdistantes crassae latae aurantiae. Stipes centralis strictus ±aequalis tenax tortilis pubescens vel fibrillosus vel *fibrilloso-pruinosus, pubescentis aurantiis, superfacies flava. Basidiosporae in cumulo albae, 12.1–14.3 × 5–7.1 µm, inamyloideae. Hymenium pigmento aurantio in solutionibus alkalicis dissolventibus. Pleurocystidia nulla. Cheilocystidia dispersa, hyalina, parietibus tenuibus et glabris. Setae pileipellis sparsae dextrinoideae, parietibus crassis, interdum 2-3 septatae, apicibus obtusis vel subacutis vel subcapitatis. Setae stipitipellis abundantes dextrinoideae, parietibus tenuibus vel crassis, apicibus obtusis, aliter setae pileipellis similis. Fibulae praesentes.*

Etymology: In honor of Sr. Abellardo "Tico" Tudela R., of Rurrenabaque, whose logistical support aided in the discovery of this species.

Pileus 1−3(−4) cm broad, convex to plane, dry or moist and greasy then fading when drying but not truly hygrophanous, orange (7A8−7B8) fading to a paler orange (6A7−6B7 to 6A8−6B8 to near 5A6), sulcate to subsulcate to the disc, even on disc, tomentose to matted subtomentose on disc, faintly so toward margin, more yellowish on ridges with age and remaining orange in sulcae; margin even. *Flesh* pale orange (5A2) in pileus, pale yellowish in stipe apex and below, up to 2 mm thick. *Odor* mild. *Taste* styptic but not unpleasant. *Lamellae* adnexed to subfree, subdistant, thick and broad (up to 7 mm), orange (7A8 to 6A8) but slightly paler toward the even, nonmarginate edges; with lamellulae in 1−2 tiers. *Stipe* (1−)2.5−7 cm long, (1−)3−4 mm broad, insititious, strict, central, twisted, tough, ± equal but often broadest at apex and base, sometimes with a bulb at base; surface pubescent to fibrillose to fibrillose-pruinose overall, denser toward the base, with orange (color range as cited above) fibrils on yellowish ground above and below when young, brown toward base with age, sometimes cream-colored slightly at base; interior stuffed, not hollow.

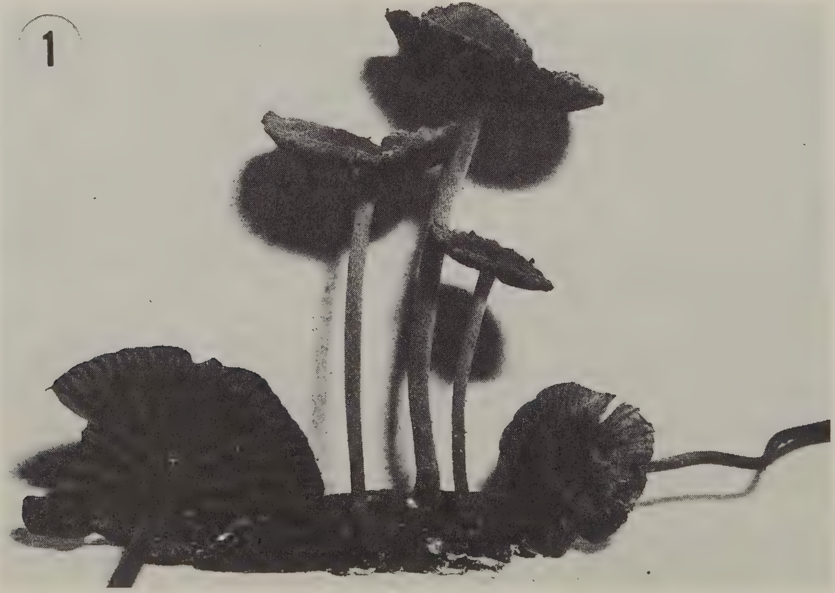
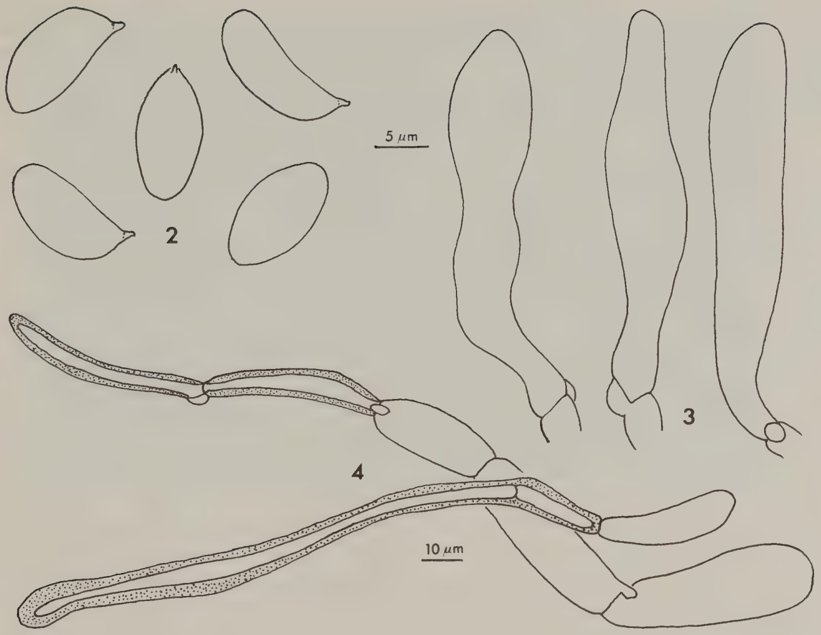


Fig. 1. *Crinipellis ticoi*. (*Halling 6393*). ×1.



Figs. 2–4. Microscopic features of *Crinipellis ticoi* (*Halling 6433*). 2. Basidiospores. 3. Cheilocystidia. 4. Setae from pileipellis.

Basidiospores white in deposit, (10–)12.1–14.3 × 5–7.1 μm (n = 20, x = 13 × 5.8 μm, Q = 2.3), ellipsoid to suballantoid and inequilateral in profile, ellipsoid to subcylindric in abaxial view, inamyloid and acyanophilous, smooth, thin-walled. *Hymenium* embedded in an amorphous golden orange pigment that dissolves in alkali. *Basidia* 28–35 × 7–8.4 μm, clavate, 4-sterigmate, not siderophilous. *Pleurocystidia* absent. *Cheilocystidia* scattered, inconspicuous, hyaline, thin-walled, smooth, subfusoid to subcylindric, 38–49 × 6–8 μm. *Lamellar trama* interwoven, inamyloid; hyphae smooth, thin-walled, 3.5–12.6 μm diam. *Pileus trama* radially oriented, inamyloid; hyphae smooth, thin-walled, 5–10(–14) μm diam. *Setae* sparsely distributed on pileus surface especially toward the margin, more abundant on the disc, 70–210 × 5–9 μm, thick-walled, dextrinoid, occasionally 2–3 septate, with obtuse to subacute to subcapitate apices, arising from a *pileipellis* of radially oriented, repent, thin-walled, hyaline hyphae; cells 7–14(–17.5) μm in diam, sometimes lightly encrusted and slightly inflated. *Setae* abundant on stipe surface, strict or curved, dextrinoid, thin- to thick-walled, with obtuse apices, otherwise resembling setae in pileipellis, arising from a *stipitipellis* whose elements are vertically oriented, dextrinoid, smooth, and thin-walled, 3.5–6 μm diam. *Clamp connections* present.

On rotten wood in lowland Amazonian rainforest.

Additional material examined: BOLIVIA. Dpto. Beni: Prov. Iturralde, S of Rurrenabaque, along Río Beni between town of Rurrenabaque and junction of Río Tuichi, ±67°30'W, 14°25'S, 4 Apr 1990, *Halling 6393* (LPB, NY). Prov. Gral. José Ballivián, ±1 km E of Rurrenabaque, along road to airport, ±67°30'W, 14°20'S, 29 Mar 1990, *Halling 6372* (LPB, NY); S of Rurrenabaque, along Río Beni between town of Rurrenabaque and junction of Río Tuichi, ±67°30'W, 14°25'S, 3 Apr 1990, *Halling 6383* (LPB, NY), 7 Apr 1990, *Halling 6416* (LPB, NY).

Crinipellis ticoi seems best accommodated in sect. *Iopodinae* (Singer, 1976) characterized by the brightly pigmented pileus and tissues not greening or graying in alkali. In this section, *C. insignis* Sing., *C. purpurea* Sing., and *C. hygrocybioides* (Henn.) Sing. appear most similar. *Crinipellis insignis* differs in the purple to purplish pink pileus, white lamellae, and short, eccentric stipe. *Crinipellis purpurea* is distinguished by the dark purple red pileus, white lamellae, and smaller spores (6.5 – 10.3 × 3 – 4.7 μm). Also, both of these species are described as having abundant setae giving the pileus a pilose aspect. *Crinipellis ticoi* has a tomentose pileus with scattered setae. Comparison of *C. ticoi* to *C. hygrocybioides* is more problematical. When Singer (1989) transferred *Marasmius hygrocybioides* Henn. to *Crinipellis*, he did not provide further data or documentation other than to indicate that the type is a species of sect. *Ionopodinae* [sic]. Henning's (1902) original description tersely describes a yellow orange, small, marasmioid fungus. Two isotypes (Kamerun. Bipindi, Mai 1899, *G. Zenker 2039*, PC!; K!) have been compared. The Kew material consists of one basidiome which was not examined microscopically. The Paris specimen contains some 14 complete basidomata and additional stipes lacking pilei. Abundant dextrinoid setae are present on the pileus and stipe indicating *Crinipellis*, but spores and cystidia were not observed. Contrary to *C. ticoi*, *C. hygrocybioides* is a smaller fungus (pileus 6 – 11 mm broad, stipe 10 – 20 × 0.5 – 0.8 mm) and has an umbilicate to papillate pileus which is pilose at the margin.

Chaetocalathus magnus Halling, sp. nov. Figs. 5 – 8

TYPE: COLOMBIA. Dpto. Antioquia: Mpio. Guarne, near Centro Experimental Piedras Blancas, 14 km E of Medellín, 75°29'W, 6°15'N, 2350 m, 28 Nov 1988, *Halling 6159* (Holotype: HUA; Isotype: NY).

Basidiomata estipitata. Pileus siccus pigmento brunneo, primo planus et minime granulosus vel velutinus tum rugulosus vel subsulcatus. Lamellae primo confertae et albae tum subdistantes et aurantio-albae. Basdiosporae 9.3–12.1 × 6.4–8.6 μm, dextrinoideae et cyanophilae. Pleurocystidia rarissima, inamyloidea, aliter cheilocystidia simili. Cheilocystidia inferme dextrinoidea, nonincrustata, parietibus crassis vel tenuibus, appendiculis apicalibus. Setae pileipellis dextrinoideae, parietibus crassis, apicibus obtusis. Fibulae praesentes.

Etymology: Latin *magnus*, great or large.

Basidiomata nonstipitate. *Pileus* (0.7 –)1 – 2.2(– 2.7) cm broad, pendant-ungulate to barely laterally attached, dry, even and matted velutinous to minutely granulose and burnt sienna to brick red (7D8 – 7) when young, soon rugulose to subsulcate and fading to near grayish orange (6B5), white to tan near attachment point. *Flesh* thin, pallid. *Odor* and *taste* mild. *Lamellae* close and white when young with unequal widths and barely subfimbriate edges, soon subdistant and orange white, afimbriate, subintervenose.

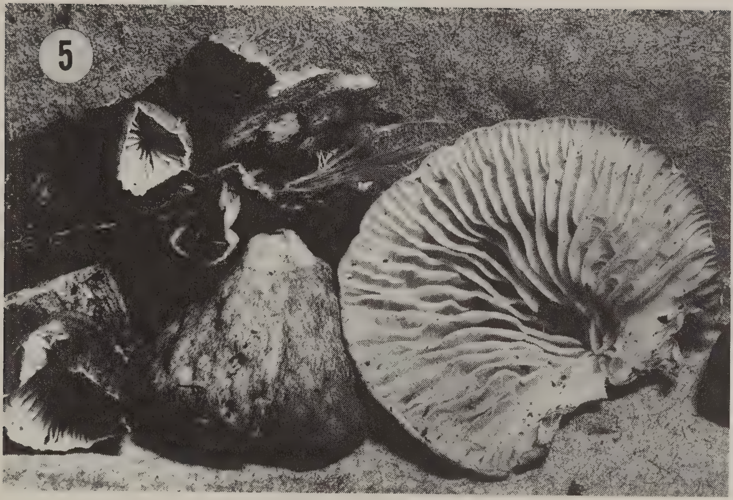
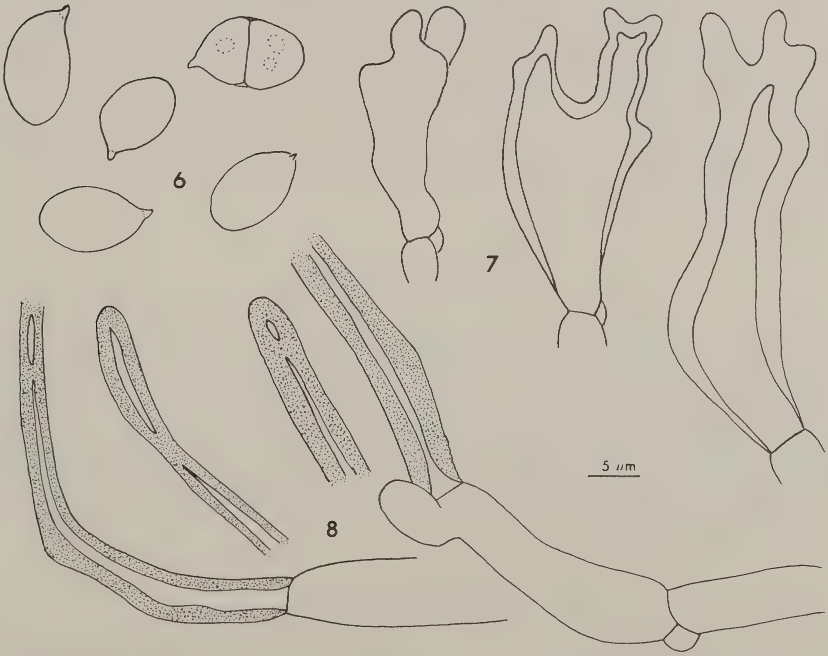


Fig. 5. *Chaetocalathus magnus* (*Halling 6159*). ×2.



Figs. 6–8. Microscopic features of *Chaetocalathus magnus* (*Halling 6159*). 6. Basidiospores. 7. Cheilocystidia. 8. Setae from pileipellis.

Basidiospores 9.3 – 12.1 × 6.4 – 8.6 μm (n = 20, x = 10.4 × 7 μm, Q = 1.5) broadly ellipsoid, sometimes subamygdaliform, weakly dextrinoid when observed singly, more strongly so in mass, cyanophilous, hyaline in KOH, smooth, thin-walled, with a slightly thickened wall in age, occasionally transversely septate. *Basidia* 28 – 35 × 8 – 9.5 μm, clavate, hyaline, thin-walled, not siderophilous, 4-sterigmate, *Pleurocystidia* inconspicuous and extremely rare, thick-walled, inamyloid, otherwise resembling cheilocystidia. *Cheilocystidia* 25 – 46 × 10 – 15 μm, thin-walled or thick-walled, with 2 – 4 apical appendages, typically subcylindric, not encrusted, usually inamyloid or very rarely weakly dextrinoid, and then the reaction extremely localized on a given cystidium. *Lamellar* and *pileal trama* interwoven, hyaline, inamyloid, not gelatinous; hyphae 5 – 7 μm broad, filamentous, thick-walled (up to 3 μm). *Pileipellis* an interwoven layer of repent, hyaline, inamyloid hyphae, 4 – 8 μm in diam, lightly encrusted with pigment, thin-walled to progressively thicker-walled as they give rise to setoid hairs; *setae* 100 – 200 μm × 3.5 – 7 μm, thick-walled, sometimes entirely lacking a lumen, dextrinoid, smooth, highly refractive to pale golden in KOH, with obtuse apices. *Clamp connections* present.

On stems of *Vaccinium* (Ericaceae) in *Quercus humboldtii* forest.

Additional material examined: COLOMBIA. Dpto. Antioquia: Mpio. Guarne, near Centro Experimental Piedras Blancas, 14 km E of Medellin, 75°29'W, 6°15'N, 2350 m, 10 Nov 1988, *Desjardin 4763* (HUA, SFSU).

This is the eighth species of *Chaetocalathus* known from the Neotropics, and the second known from Colombia [after the widespread *Ch. liliputianus* (Mont.) Sing.]. *Chaetocalathus magnus* fits best in sect. *Holocystis* Sing. by virtue of the dextrinoid (rarely), thick-walled, apically appendaged cystidia. However, it can be distinguished easily by its large size, brown pigmentation of the non-pilose pileus, non-encrusted cystidia, and lack of entire and simple pleurocystidia. However, when pleurocystidia are present, they are extremely rare and resemble the inamyloid cheilocystidia.

ACKNOWLEDGMENTS

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LITERATURE CITED

Baroni, T. J. & R. E. Halling. 1992. New species of *Rhodocybe* from South America with a key to species. *Mycologia* 84: 411–421.

Halling, R. E. 1989a. A synopsis of Colombian Boletes. *Mycotaxon* 34: 93–113.

____. 1989b (1990). Notes on *Collybia* III. Three neotropical species of subg. *Rhodocollybia*. *Mycologia* 81: 870–875.

____. 1992. A new species of *Boletus* section *Luridi* from Colombia. *Brittonia* 44: 108–113.

____, & C. L. Ovrebo. 1987. A new species of *Rozites* from oak forests of Colombia with notes on biogeography. *Mycologia* 79: 674–678.

Hennings, P. 1902. Fungi camerunensis novi. III. Bot. Jahrb. Syst. 30: 39–57.

Horak, E. & R. E. Halling. 1991. New records of *Phaeocollybia* from Colombia. *Mycologia* 83: 464–472.

Kornerup, A. & J. H. Wanscher. 1983. *Methuen Handbook of Colour.* Ed. 3. Eyre Methuen Ltd., London.

Singer, R. 1942. A monographic study of the genera *Crinipellis* and *Chaetocalathus*. *Lilloa* 8: 441–534.

____. 1976. Marasmieae (Basidiomycetes–Tricholomataceae). *Flora Neotrop. Monogr.* 17: 1–347.

____. 1989. New taxa and new combinations of Agaricales (Diagnoses fungorum novorum Agaricalium IV). *Fieldiana, Bot., n.s.* 21: 1–133.

____, C. L. Ovrebo, & R. E. Halling. 1990. A new species of *Phylloporus* and a new species of *Tricholomopsis* from Colombia with notes on *Phylloporus boletinoides*. *Mycologia* 82: 452–459.

Tulloss, R. E., C. L. Ovrebo, & R. E. Halling. 1992. Studies on *Amanita* (Amanitaceae) from Andean Colombia. *Mem. New York Bot. Gard.* 66: 1–46.

MYCOTAXON

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SEPTORIA THYMI SP. NOV. FROM BULGARIA

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ABSTRACT. A new species of the genus *Septoria* Sacc. (Coelomycetes), *Septoria thymi* Sameva et Bakalova sp. nov. from Bulgaria is described and illustrated.

During inventory investigations of the genus *Septoria* Sacc. (Sphaeropsidales, Coelomycetes) in Bulgaria, a new species belonging to this genus is established.

Septoria thymi Sameva et Bakalova, sp. nov.

Maculae 0.1-0.3 cm in diam, orbiculares vel irregularis, solitariae, albidis, ochraceae vel pallide-brunneae indistincto atropurpureo marginate. Pycnides epiphylae, globosae vel depresso-globosae tenuiter tunicatae, pallido-brunneae, 140-180 μm in diam, poro orbiculari 10-20 μm in diam, cellulis parvis obscurioribus cincto. Conidia cyindrica, elongato-fusiformia, clavata, utrinque rotundata, recta vel leniter curvata, 3-5(7) septata, hyalina, 30.0-($\bar{X}$=38.94; S=4.31)-54.0 x 2.5-($\bar{X}$=3.41; S=0.43)-5.0 μm, N=100 (Figs. 1, 2).

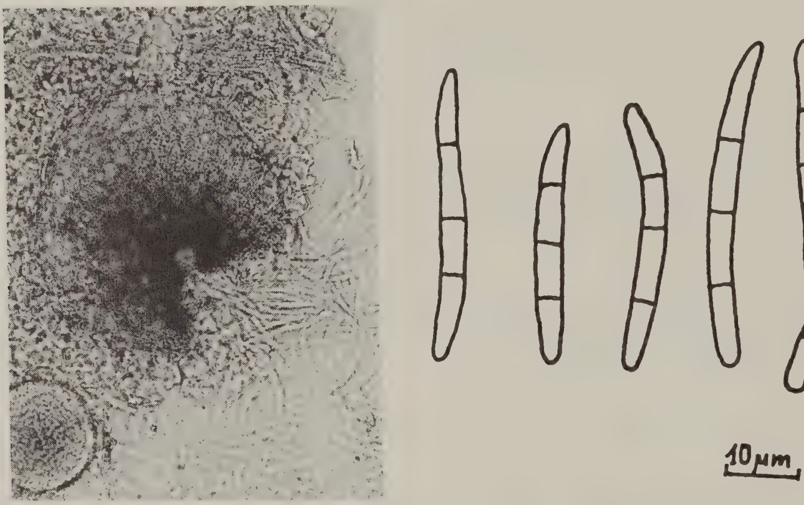
In foliis Thymi pulegioidi L., Bulgaria, mons Vitosha, supra pagum Bistrica, 13.07.1980, E. F. Sameva, G. G. Bakalova, SOM 20763 M, holotypus.

In speciebus Thymi Septoria primum observatur.

Leaf spots 0.1-0.3 cm in diam, rounded or irregular, single, whitish, ochraceus or pale brown, surrounded by a brown or purple border. Pycnidia epiphyllous, spheric or flattened, with thin walls, pale brown, 140-180 μm in diam, with circular ostiole, surrounded by darker cells, 10-20 μm in diam. Conidia cylindric, fusiform or clavate, rounded at both ends, straight or slightly curved, 3-5 (rarely 7) septate, hyaline, 30.0-($\bar{X}$-38.94; S=4.31)-54.0 x 2.5-($\bar{X}$=3.41; S=0.43)-5.0 μm. N=100 (Figs. 1, 2).

On leaves of *Thymus pulegioides* L., Bulgaria, Mount Vitosha, above the village of Bistritsa, 13.07.1980, E. F. Sameva, G. G. Bakalova, SOM 20763 M (holotype).

First description of a species of *Septoria* Sacc. on *Thymus* L.



Figs. 1, 2. Pycnidium and conidia of *Septoria Thymi*

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THREE NEW SPECIES AND A NEW VARIETY OF PLUTEUS FROM THE UNITED STATES

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ABSTRACT: Three previously unreported taxa, *Pluteus cinerascens*, *P. heterocystis*, *P. laricinus*, and *P. salicinus* var. *americanus* were discovered during field and herbarium studies of *Pluteus* section *Pluteus* (Pluteaceae, Agaricales) in the United States. They are described below as new.

KEY WORDS: Agaricales, *Pluteus*, United States.

The genus *Pluteus* Fr. (Pluteaceae, Agaricales) is a large group of presumably non-mycorrhizal mushrooms found on all continents excepting Antarctica (Singer 1986). The genus has three sections: *Pluteus* Fr., *Hispidoderma* Fayod and *Celluloderma* Fayod. In section *Pluteus*, the pileipellis is a filamentous cutis with cylindric or cylindric-fusoid end-cells; the hyphae are appressed with the end-cells sometimes erect or suberect in fascicles. The pleurocystidia are metuloid. Metuloid cystidia are thick-walled, ventricose (i. e., swollen in the middle), and usually with apical projections.

In the following descriptions, color names within quotes are from Ridgway (1912, = R); Kelly and Judd (1976, = NBS); and the Royal Botanic Garden Color Chart (1969, = RBG). Color names without quotes are author-generated.

All anatomical observations were made in 3% KOH.

The following are definitions used to describe pleurocystidia: "cervinus-type" refers to pleurocystidia with apical ornamentations while "magnus-type" indicates pleurocystidia without apical ornamentations (modified after Singer 1956).

Unless otherwise noted, herbarium abbreviations (Holmgren et al. 1990) for specimens examined are given in parentheses after the specimen number. Standard two-lettered abbreviations are used for American states.

Pluteus cinerascens P. Banerjee et W. J. Sundberg, sp. nov. Fig. 1.

Speciebus aliis sectionis Plutei, pileo 2-7 cm lato, margine cinerasci ubi vulnerato (injurio vel contuso); cervini-pleurocystidiis metuloideis ventricosis, tunica ±2.2 µm crassa, apice acuto vel truncato, appendiculo, cornibus 2-4 plerumque fortibus longis acutis; epicutis pilei fibulis destituta.

Holotypus: A. H. Smith 57433! (MICH). Solitary on a very rotten log, Proud Lake Recreation Area, Oakland Co., Michigan, U.S.A.

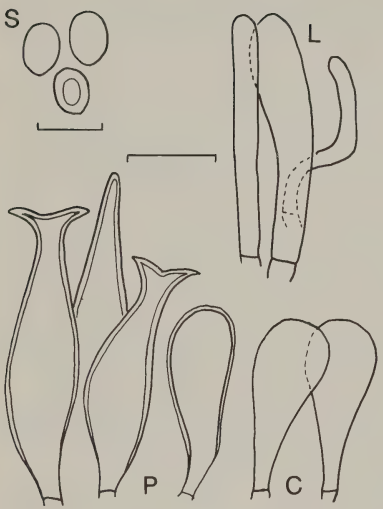
Pileus 2-7 cm broad, broadly convex with a slightly flattened disc, surface with small fascicles of appressed, cinnamon-buff fibrils on a white ground color over the disc, white and glabrous elsewhere, a dingy orange flush developing in some areas overnight, injured and bruised places along margin becoming "cinereous" (R) to "clay buff" (RBG); context white, soft; odor and taste raphanoid. Lamellae free and remote from stipe, close, broad, white becoming dingy pale "vinaceous" (R) to "vinaceous buff" (RBG), edges serrulate, concolorous with lamellae, beaded with drops when fresh; lamellulae 1-2-tiered. Stipe 6.5-10 cm long, 0.2-1 cm thick at apex, base cylindrical to clavate and up to 1.5 cm broad, naked above, lower third may or may not have appressed fibrils, fibrils white overall but staining or discoloring gray to fuliginous in injured places and with dingy "ochraceous" (R) streaks over the base; solid but fragile.

Basidiospores 6-7.4 x 4.4-5.6 µm, oval-ellipsoid, wall smooth, moderately thick, rarely collapsing, with hyaline cytoplasmic content, some with a large lipid droplet; hilar appendix inconspicuous. Basidia 20-28 x 7-8.4 µm, clavate; four-spored. Pleurocystidia very abundant, (30-)42-85 x 12-22 µm, ventricose, thick-walled (1.4-2.0 µm), almost all hyaline ("content pale lilac in KOH when fresh", Smith, unpublished); of cervinus-type, apex acute to truncate and with (1-)2-4(-5) well-developed, mostly long and sharp apical hooks, some pleurocystidia with short to blunt apical hooks, lateral spinules occasionally present, occasional sphaeropedunculate pleurocystidia interspersed with those of the cervinus-type; pleurocystidia near lamellar edge mostly of cervinus-type interspersed with a few magnus-type. Cheilocystidia not abundant to abundant, in fascicles when abundant; 30-65 x 12-22 µm, sphaeropedunculate, hyaline; with a tendency to gelatinize when remoistened. Pileipellis hyphae 4-12 µm in diameter, ends rounded, most hyaline, some with a homogeneous dark to light brown content; pellicle in cross section easily separates from the context; clamp connections absent on pileipellis hyphae.

Other collections examined: Klavins s. n., Pomona Natural Bridge, Jackson Co., IL (SIU).

Observations: The morphological and anatomical characters are significant enough to describe it as a new species. A. H. Smith (unpublished) considered *P. cinerascens* close to *P. magnus* McClatchie, but the presence of very strongly developed long, sharp pleurocystidial hooks indicate closer affinities to *P. cervinus* (Schaeff.: Fr.) Kumm. The cinerous stains and the strongly developed hooks on many of the pleurocystidia distinguish it. A solitary liginicolous basidiocarp of the type specimen was collected from Michigan by A. H. Smith, and another solitary terrestrial basidiocarp has been found recently in Illinois.

Figs. 1-4. Anatomical characters of *Pluteus* species. 1. *Pluteus cinerascens* sp. nov.; 2. *P. heterocystis* sp. nov.; 3. *P. laricinus* sp. nov.; 4. *P. salicinus var. americanus* var. nov. (P: Pleurocystidia; C: Cheilocystidia; L: Pileipellis; B: Basidia; S: Basidiospores. Scale lines: 10 µm for basidiospores; 20 µm for other structures).



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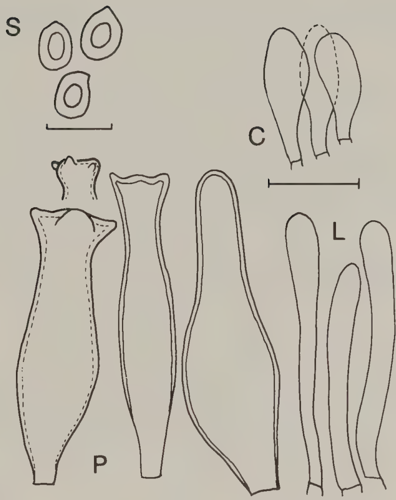

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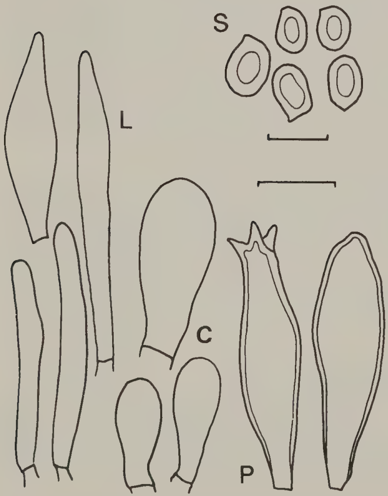

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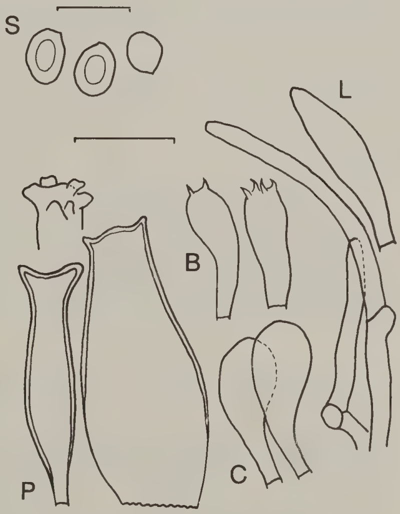

The morphological description as well as notes on its habit, habitat and distribution of the type specimen are adapted from data obtained by A. H. Smith (unpublished).

Pluteus heterocystis P. Banerjee et W. J. Sundberg, sp. nov. Fig. 2.

Speciebus aliis sectionis Plutei, pileo 5 cm lato, disco umbrino et fusco fibrillulo in strias versus marginem radiatim; lamellis crassis marginibus cariosis; pleurocystidiis metuloideis clavatis late ventricosis, apice obtuso vel rotundato, appendiculo cornibus brevibus vel nullis; epicutis pilei fibulis destituta.

Holotypus: A. H. Smith 13616! (MICH). Solitary on soil, Hoh River, Olympic National Park, Washington, U.S.A. Known only from the type collection.

Pileus 5 cm broad, expanded-umbonate, umbo obtuse, moist to subviscid (as in *Inocybe geophylla*); disc "Saccardo's umber" (R) and with dark fibrils extending as streaks toward the margin; marginal area watery gray but opaque; odor and taste not recorded. Lamellae free, remote from the stipe, close, moderately broad, somewhat thick, white becoming dingy pink; edges eroded and pallid; lamellulae 1-2-tiered. Stipe 7 cm long, 1 cm thick at apex, equal to a slightly bulbous base, glabrous over most of the surface, some "umber" (RBG) fibrillose streaks present on lower portion; solid; context pallid.

Basidiospores 6.6-8(-9) x 5.6-6.4(-7) µm, broadly ovate to ellipsoid, smooth, wall slightly thick, some hyaline and with a large lipid droplet, some with cytoplasmic content; hilar appendix visible. Basidia 24-32 x 8-10 µm, clavate, usually 4-spored, occasionally 2-spored, hyaline. Pleurocystidia abundant and dimorphic: one form 50-80 x 10-25 µm, clavate to broadly fusoid-ventricose, apices more or less truncate, many with several short horns at apex and others merely with aborted apical ornamentation; the second form with apex rounded and lacking horns, wall uniformly 1.2-1.8 µm thick, no lateral ornamentation seen; all pleurocystidia hyaline. Cheilocystidia 35-45(-54) x 8-12.6 µm, clavate-pedicellate to slightly ventricose, thin-walled, hyaline; apices obtuse to rounded, smooth. Pileipellis of radial hyphae 6-10 µm in diameter; end cells often subfusoid and 9-14 µm in diameter; content hyaline or rarely dingy yellow-brown, rarely a few hyaline pilocystidia (15-25 µm diameter) visible; clamp connections not seen on pileipellis hyphae.

Observations: The thick gills with eroded edges, and the presence of two types of pleurocystidia with one form having truncated apices with short ornamentations are distinctive. A. H. Smith (unpublished) found clamp connections in the pileipellis, but our repeated attempts failed to demonstrate them.

The morphological description as well as data on its habit, habitat and distribution are modified from notes of A. H. Smith (unpublished).

Pluteus laricinus P. Banerjee et W. J. Sundberg, sp. nov. Fig. 3.

Speciebus aliis sectionis Plutei, pileo 1.5 cm lato, fusci-umbrino, squamuloso in disco; lamellis albis ad marginem pilei griseolis; epicute pilei fibulis infrequentibus; stipite gracili, 0.2 cm in diametro ad apicem.

Holotypus: A. H. Smith 38888! (MICH). Solitary on a rotten larch log. Proud Lake Recreation Area, Oakland Co., Michigan, U.S.A. Known only from the type collection.

Pileus 1.5 cm broad, convex-umbonate, squamulose on the disc, elsewhere appressed-fibrillose, dark "wood brown" (R); margin slightly wavy but not striate. Lamellae broad, remotely free, close, white, becoming pale pink and edges grayish near cap margin; lamellulae 1-2-tiered. Stipe 3 cm long, 2 cm thick at apex, only slightly enlarged downward, whitish and not darkening, with faint "avellaneous" (R) pruina near base.

Basidiospores (4.4-)5-6.4 x 4.6-5 µm, oval-ellipsoid, smooth, wall only slightly thick, hyaline or nearly so; hilar appendix visible. Basidia 22-25 x 6-7.4 µm, clavate, four-spored, hyaline. Pleurocystidia 35-75 x 8-20 µm, fusoid-ventricose, hyaline, wall of upper part thicker (1.2-1.5 µm thick) than lower part; most pleurocystidia near the gill edge are of magnus-type (i.e., without hooks), others with 2-3 hooks at the apex, rarely with 1 lateral hook. Cheilocystidia 28-48 x 10-14.6 µm, clavate-pedicellate to broadly fusoid, smooth and apices rounded, walls thin, content hyaline to dingy brownish. Pileipellis hyphae 3-5 µm in diameter, with rounded to subacute apices, occasionally hyphal end cells fusoid-ventricose. Pilocystidia 85-150 x 8-14 µm, deeply embedded in the pileal trama, content of all pileipellis hyphae hyaline or dull yellow brown; clamp connections on pileipellis hyphae present but not frequent.

Observations: The small spores, the grayish gill margin, and slender stipe distinguish the species. A. H. Smith (unpublished) found abundant clamp connections on pileipellis hyphae, but after repeated attempts, we found only a few.

The morphological description as well as notes on its habit, habitat and distribution are adapted from notes by A. H. Smith (unpublished).

Pluteus salicinus var. americanus P. Banerjee et W. J. Sundberg, var. nov. Fig. 4.

Varietatibus aliis Plutei salicini, pileo 5-6 cm lato, glabro hygrophano, ad marginem translucidi-striato; pleurocystidiis acutis vel truncatis, appendiculis cornibus apicis complexis; epicute pilei fibuligera.

Holotypus: A. H. Smith 57841! (MICH). Solitary on aspen wood. Pellston Hills, west of Pellston, Michigan, U.S.A.

Pileus 5-6 cm broad, broadly convex expanding to plane with no umbo, color between "drab" (R) and "hair brown" (R), surface moist and hygrophanous, sometimes turning greenish-gray upon handling or drying, opaque when faded; lacking any spinules or squamules over disc; margin translucent-striate fading to an ashy gray; context watery grayish fading to pallid; odor of crushed context disagreeable, taste very disagreeable: somewhat metallic. Lamellae fairly broad, remote, close, whitish pallid, "pink" (NBS) in age; edges concolorous; lamellulae 1-2-tiered. Stipe 4-6 cm long, 0.5-0.6 cm thick, silvery whitish to grayish and base soon staining greenish gray when handled or dried; naked; hollow, terete or compressed.

Basidiospores 8-10(-11) x 6.4-7.4 µm, ellipsoid to ovoid, smooth, hyaline, wall slightly thick; hilar appendix conspicuous. Basidia 28-34 x 7-8.8 µm, clavate, both 2- and four-spored. Pleurocystidia abundant, 50-85 x 12-28 µm, ventricose to very broadly fusoid with apex more or less truncate, some with simple sharp and pointed projections, some others with short (2-5 µm) truncate projections arising around the neck and these usually with a crown of 4-5 small but pronounced projections around their apices (i.e., primary and secondary ornamentations present), rarely some aborted ornamentations observed on the neck just below the apex; wall from ventricose portion downward to pedicel becoming thin and readily collapsing, 1.2-1.4 µm thick near neck, ±1 µm thick near pedicel; all pleurocystidia hyaline. Cheilocystidia in fascicles, 34-46 x 12-20 µm, sphaeropedunculate to clavate-pedicellate, thin-walled, smooth, hyaline. Pileipellis a trichoderm formed of dimitic hyphae 3-6 µm in diameter, occasionally with cystidioid end-cells up to 16 µm in diameter, content pale brownish "fuscous" (R) to dingy brown; clamp connections present on pileipellis hyphae.

Other collections examined: A. H. Smith 57846, MI (MICH); A. H. Smith 57099, MI (MICH); A. H. Smith 57787, MI (MICH)—no other data available on these collections; TN 14277, Indian Creek woods, Great Smoky Mountains National Park, Swain Co., NC (TENN).

Observations: This taxon is in the *Pluteus salicinus* (Pers.: Fr.) Kumm. group, but is distinctive because of its hygrophanous pileus with translucent-striate margin when moist. Also, the presence of some pleurocystidia with compound apical ornamentations is distinctive. Among the other recognized American varieties of *P. salicinus, P. salicinus var. salicinus* is not hygrophanous, and *P. salicinus var. achloes* Sing. is occasionally hygrophanous. Moreover, these two varieties almost never have pleurocystidia with compound apical ornamentations. In *P. salicinus var. americanus*, the stipe (and sometimes pileus) turn dark bluish-fuscous upon handling or drying which is quite distinctive for a *Pluteus* but this character is present to some extent throughout the *P. salicinus* group.

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LITERATURE CITED

Henderson, D. M., P. D. Orton, and R. Watling. 1969. Colour Identification Chart. British Fungus Flora. Agarics and Boleti: Introduction. Royal Botanic Garden, Edinburgh. 84 pl.

Holmgren, P. K., N. H. Holmgren, and L. C. Barnett (Eds.). 1990. Index Herbariorum. Part I. 8th Ed. New York Botanical Garden, Bronx. 693 p.

Kelly, K. L., and D. B. Judd. 1976. Color. Universal Language and Dictionary of Names. Nat. Bur. Stand. Spec. Publ. 440. U. S. Gov't. Printing Office, Washington, D. C. 158 p.

Ridgway, R. 1912. Color Standards and Color Nomenclature. Publ. by the author. Washington, D. C. 43 p.+ 53 pl.

Singer, R. 1956. Contributions toward a monograph of the genus *Pluteus*. Trans. Brit. Mycol. Soc. 39(2): 145-232.

Singer, R. 1986. The Agaricales in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein, F.R.G. 981 pp.

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WORLD LIST OF CETRARIOID LICHENS

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Abstract. The list sums up 120 cetrarioid lichen species. The present generic location and valid epithet is indicated for each of them. The generic location of 27 species (marked with *) is not acceptable but not yet converted. Information available about 9 species (marked with ?) is unsufficient.

This is the first attempt after 40 years (Rassadina, 1950; Räsänen, 1952) to compile a total list of cetrarioid lichens. The terms "cetrarioid", "parmelioid" and "alectoroid lichens" are nowadays in wide use but not strictly defined. All those terms indicate the certain morphological trends in the fam. Parmeliaceae, "cetrarioid" being perhaps the most unlimited of the three. Classically foliose thallus with dorsiventral structure which is not closely adnate to the substrate is characteristic to this trend as well as dominating marginal position of apothecia and pycnidia. We have followed this classical treatment and comprised into the list of cetrarioid lichens all the species corresponding to those general characters. According to the contemporary taxonomy the cetrarioid lichen species may belong to different genera while most of them have earlier been included in the genus *Cetraria*. The latter was described in 1803 by Erik Acharius and consisted then of 8 species. The number of species in the genus has varied greatly being the biggest (76) in the treatment of the Russian lichenologist Ksenya Rassadina in 1950. At present the obvious trend in the systematics of the fam. Parmeliaceae is towards the delimitation of small and more or less homogeneous genera. During last decades 13 separate genera of cetrarioid lichens have been newly described or resurrected: *Ahtiana* (Goward, 1985), *Allocetraria* (Kurokawa & Lai, 1991), *Asahinea* (Culberson & Culberson, C.,1965), *Cetrariopsis* (Kurokawa, 1980), *Cetrelia* (Culberson & Culberson, C., 1968), *Cetreliopsis* (Lai, 1980), *Esslingeriana* (Hale & Lai in Lai, 1980), *Masonhalea* (Kärnefelt, 1977), *Nephromopsis* (Müller Argoviensis, 1891; resurrected by Lai in 1980), *Parmelaria* (Awasthi, 1987), *Platismatia* (Culberson & Culberson, C., 1968), *Tuckermannopsis* (Gyelnik, 1933; resurrected by Hale in Egan, 1987) and *Vulpicida* (Mattsson & Lai, 1993). Among these units the genera *Cetraria* and *Tuckermannopsis* are still the conglomerates of poorly connected taxa and in urgent need of further studies. Description of some more new cetrarioid genera are expected in the near future.

In our list the specific epithets are presented in the alphabetical order. The present generic location and valid epithet is indicated for each of them. All together 120 species are accepted as separate. Their epithets are numbered. The epithets without numbers are treated as synonyms, or they represent the species of other, not cetrarioid genera. There is not much information available about 9 species which may therefore turn out to be either synonyms or belong even to quite different genera. These species are marked with ? in the list. The species which present generic location is not acceptable but not yet converted, are marked with *. The synonymity of some species is still doubtful. On these occasions the marks =? are used.

aculeata (Schreber) Fr. [*Cetraria*] = *Coelocaulon aculeatum* (Schreber) Link
*1. *agnata* (Nyl.) Krist. [*Cetraria*] = *Cetraria agnata* (Nyl.) Krist.
2. *alaskana* Culb.& C.Culb. [*Cetraria*] = *Cetrelia alaskana* (Culb. & C.Culb.) Culb.& C.Culb.
?3. *albopunctata* Zahlbr. [*Cetraria*]
aleurites (Ach.) Th.Fr. [*Cetraria*] = *Imshaugia aleurites* (Ach.) S.F.Meyer
alvarensis (Wahlenb.) Lynge [*Cetraria*] = *Vulpicida tubulosus* (Schaerer) J.-E.Mattsson & Lai
4. *ambigua* Bab. [*Cetraria*] = *Allocetraria ambigua* (Bab.) Kurok. & Lai
americana Sato [*Cetraria*] = *Tuckermannopsis orbata* (Nyl.) Lai
5. *americana* Sprengel [*Nephroma*] = *Tuckermannopsis americana* (Sprengel) Hale
6. *andrejevii* Oxner [*Cetraria*] = *Cetraria andrejevii* Oxner
?7. *annae* Oxner [*Cetraria*]
?8. *antarctica* Zahlbr.
aradensis Gyelnik [*Pseudoparmelia*] = *Cetrelia olivetorum* (Nyl.) Culb. & C.Culb.
arborialis (G.K.Merr.) Howard [*Cetraria*] = *Cetraria subalpina* Imsh.
arctica (Hook.) Tuck. [*Cetraria*] = *Dactylina arctica* (Hook.) Nyl.
arctica Magnusson [*Cetraria*] = *Cetraria nigricascens* (Nyl.) Elenkin
9. *arenaria* Kärnef. [*Cetraria*] = *Cetraria arenaria* Kärnef.
10. *asahinae* Sato [*Cetraria*] = *Nephromopsis asahinae* (Sato) Räsänen
atlantica (Tuck.) Du Rietz [*Cetraria*] = *Platismatia tuckermanii* (Oakes) Culb. & C.Culb.
*11. *aurescens* Tuck. [*Cetraria*] = *Tuckermannopsis aurescens* (Tuck.) Hale
12. *australiensis* W.Weber ex Kärnef. [*Cetraria*] = *Cetraria australiensis* W.Weber ex Kärnef.
bavarica Krempelh. [*Cetraria*] = *Tuckermannopsis oakesiana* (Tuck.) Hale
billardieri Mont. [*Cetraria*] = *Hypogymnia billardieri* (Mont.) Filson
bohemica Anders [*Cetraria*] = *Coelocaulon aculeatum* (Schreber) Link
13. *braunsiana* (Müll. Arg.) Zahlbr. [*Cetraria*] = *Cetrelia braunsiana* (Müll. Arg.) Culb. & C.Culb.
californica G.K.Merr. [*Cetraria*] = *Tuckermannopsis merrillii* (Du Rietz) Hale

*14. *californica* Tuck. [*Cetraria*] = *Cetraria californica* Tuck.
californica Gyelnik [*Nephromopsis*] = according to the description (Gyelnik, 1931) ought to be *Tuckermannopsis orbata* (Nyl.) Lai. This is confirmed by TLC of isotype (FH) which contains protolichesterinic acid.
15. *canadensis* (Räsänen) Räsänen [*Cetraria*] = *Vulpicida canadensis* (Räsänen) J.-E.Mattsson & Lai
caperata sensu Vainio [*Cetraria*] = *Vulpicida pinastri* (Scop.) J.-E.Mattsson & Lai
capitata Lynge [*Cetraria*] = *Cetraria nigricans* Nyl.
cavernosus Menzies [*Lichen*] = *Platismatia lacunosa* (Ach.) Culb. & C.Culb.
16. *cetrarioides* (Delise ex Duby) Nyl. [*Parmelia*] = *Cetrelia cetrarioides* (Delise ex Duby) Culb. & C.Culb.
17. *chicitae* Culb. [*Cetraria*] = *Cetrelia chicitae* (Culb.) Culb. & C.Culb.
*18. *chlorophylla* (Willd.) Vainio [*Cetraria*] = *Tuckermannopsis chlorophylla* (Willd.) Hale
19. *chrysantha* Tuck. [*Cetraria*] = *Asahinea chrysantha* (Tuck.) Culb. & C.Culb.
20. *ciliaris* Ach. [*Cetraria*] = *Tuckermannopsis ciliaris* (Ach.) Gyelnik
citrina Taylor [*Cetraria*] =? *Nephromopsis pallescens* (Schaerer) Park
clarkii Tuck. [*Cetraria*] {nomen nudum} = *Nephromopsis endocrocea* Asah. f. *clarkii* Asah.
21. *collata* (Nyl.) Müll.Arg. [*Cetraria*] = *Cetrelia collata* (Nyl.) Culb. & C.Culb.
*22. *commixta* (Nyl.) Th.Fr. [*Cetraria*] = *Cetraria commixta* (Nyl.) Th.Fr.
complicata Laurer [*Cetraria*] = *Nephromopsis laureri* (Krempelh.) Kurok.
*23. *coralligera* (W.Weber) Hale [*Cetraria*] = *Tuckermannopsis coralligera* (W.Weber) W.Weber
corallophora Müll.Arg. [*Cetraria*] =*Punctelia rudecta* (Ach.) Krog
corniculata Egeling [*Cetraria*] = *Coelocaulon aculeatum* (Schreber) Link
corrugis Fr. [*Cetraria*] = *Parmotrema perforatum* (Wulfen) Hale
crispa (Ach.) Nyl. [*Cetraria*] = *Cetraria ericetorum* Opiz
24. *cucullata* (Bellardi) Ach. [*Cetraria*] = *Allocetraria cucullata* (Bellardi) Randl. & Saag
*25. *culbersonii* Hale [*Cetraria*] = *Cetraria culbersonii* Hale
culbersoniorum Trass [*Asahinea*] = *Asahinea chrysantha* (Tuck.) Culb. & C.Culb.
daibuensis Räsänen [*Cetraria*] = *Nephromopsis laxa* (Zahlbr.) Sato
26. *davidiana* Culb. & C.Culb. [*Cetrelia*] = *Cetrelia davidiana* Culb. & C.Culb.
27. *delavayana* Culb. & C.Culb. [*Cetrelia*] = *Cetrelia delavayana* Culb. & C.Culb.
28. *delavayi* (Hue) Sato [*Cetraria*] = *Nephromopsis delavayi* Hue
29. *delisei* (Bory ex Schaerer) Nyl. [*Cetraria*] = *Cetraria delisei* (Bory ex Schaerer) Nyl.
?30. *denticulata* Hue [*Cetraria*]
?31. *dermatoidea* Zahlbr. [*Cetraria*]
diffusa (Weber) Lynge [*Cetraria*] = *Imshaugia placorodia* (Ach.) S.F.Meyer
32. *ectocarpisma* (Hue) Gyelnik [*Nephromopsis*] = *Nephromopsis ectocarpisma* (Hue) Gyelnik
elenkinii Krog [*Cetraria*] = *Cetraria nigricascens* (Nyl. in Norrl.) Elenkin

33. *endocrocea* (Asah.) Sato [*Cetraria*] = *Nephromopsis endocrocea* Asah.
endoxantha Hue [*Cetraria*] = pro parte *Nephromopsis endocrocea* Asah., pro parte *Nephromopsis ornata* (Müll. Arg.) Hue
34. *endoxanthoides* Awasthi [*Cetraria*] = *Nephromposis endoxanthoides* (Awasthi) Randl. & Saag
epiphorella Nyl. in Crombie [*Cetraria*] = *Coelopogon epiphorellum* (Nyl. in Crombie) Brusse & Kärnef.
35. *ericetorum* Opiz [*Cetraria*] = *Cetraria ericetorum* Opiz
eriophylla (Knight) Zahlbr. [*Cetraria*] = *Erioderma knightii* Shirley
36. *erosa* Culb. & C.Culb. [*Platismatia*] = *Platismatia erosa* Culb. & C.Culb.
everniella (Nyl.) Krempelh. [*Cetraria*] = *Allocetraria stracheyi* (Bab.) Kurok. & Lai
fahlunensis sensu Schaerer [*Cetraria*] = *Cetraria hepatizon* (Ach.) Vainio
fahlunensis sensu Vainio [*Cetraria*] = *Cetraria commixta* (Nyl.) Th.Fr.
fallax (Weber) Ach. [*Cetraria*] = *Platismatia glauca* (L.) Culb. & C.Culb.
37. *fastigiata* (Delise ex Nyl. in Norrl.) Kärnef. [*Cetraria*] = *Cetraria fastigiata* (Delise ex Nyl. in Norrl.) Kärnef.
*38. *fendleri* (Nyl.) Tuck. [*Cetraria*] = *Tuckermannopsis fendleri* (Nyl.) Hale
39. *formosana* Zahlbr. [*Cetraria*] = *Platismatia formosana* (Zahlbr.) Culb. & C.Culb.
frostii Tuck. [*Parmelia*] = *Cetraria culbersonii* Hale
furcellata Fr. [*Cetraria*] = *Bryoria furcellata* (Fr.) Brodo & D.Hawksw.
40. *gilva* Asah. [*Cetraria*] = *Tuckermannopsis gilva* (Asah.) Lai
41. *glauca* (L.) Ach. [*Cetraria*] = *Platismatia glauca* (L.) Culb. & C.Culb.
42. *globulans* (Nyl. ex Hue) Zahlbr. [*Cetraria*] = *Nephromopsis globulans* (Nyl. ex Hue) Lai
gracilenta (Krempelh.) Vainio [*Cetraria*] = *Coelopogon epiphorellum* (Nyl. in Crombie) Brusse & Kärnef.
halei Culb. & C.Culb. [*Cetraria*] = *Tuckermannopsis americana* (Sprengel) Hale
*43. *hepatizon* (Ach.) Kurok. [*Tuckermannopsis*] = *Cetraria hepatizon* (Ach.) Vainio.
44. *herrei* Imsh. [*Cetraria*] = *Platismatia herrei* (Imsh.) Culb. & C.Culb.
hiascens (Fr.) Th.Fr. [*Cetraria*] = *Cetraria delisei* (Bory ex Schaerer) Nyl.
*45. *hypotrachyna* Müll.Arg. [*Cetraria*] = *Cetraria hypotrachyna* Müll.Arg.
iberica Crespo & Barreno [*Cetraria*] = *Tuckermannopsis merrillii* (Du Rietz) Hale
46. *idahoensis* Essl. [*Cetraria*] = *Esslingeriana idahoensis* (Essl.) Hale & Lai
*47. *inermis* (Nyl.) Krog [*Cetraria*] = *Cetraria inermis* (Nyl.) Krog
inflata J.D.Hook. & Taylor [*Cetraria*] = *Ramalina inflata* (J.D.Hook. & Taylor) J.D.Hook. & Taylor
48. *interrupta* Culb. & C.Culb. [*Platismatia*] = *Platismatia interrupta* Culb. & C.Culb.
49. *isidiata* (Asah.) Culb. & C.Culb. [*Cetrelia*] = *Cetrelia isidiata* (Asah.) Culb. & C.Culb.
50. *isidiigera* Kurok. & Lai [*Allocetraria*] = *Allocetraria isidiigera* Kurok. & Lai

51. *isidioidea* (Räsänen) Awasthi [*Cetraria*] = *Nephromopsis isidioidea* (Räsänen) Randl. & Saag
52. *japonica* Zahlbr. [*Cetraria*] = *Cetrelia japonica* (Zahlbr.) Culb. & C.Culb.
53. *islandica* (L.) Ach. [*Cetraria*] = *Cetraria islandica* (L.) Ach.
54. *juniperina* (L.) Ach. [*Cetraria*] = *Vulpicida juniperinus* (L.) J.-E.Mattsson & Lai
55. *kamczatica* Savicz [*Cetraria*] = *Cetraria kamczatica* Savicz
56. *komarovii* Elenkin [*Cetraria*] = *Nephromopsis komarovii* (Elenkin) Wei
kurodakensis Asah. [*Cetraria*] = *Asahinea scholanderi* (Llano) Culb. & C.Culb.
*57. *kurokawae* Shibuichi & Yoshida [*Cetraria*] = *Nephromopsis kurokawae* (Shibuichi & Yoshida) Kurok.
lacera J.D.Hook. & Taylor [*Cetraria*] = *Sticta lacera* (J.D.Hook. & Taylor) Müll. Arg.
58. *lacunosa* Ach. [*Cetraria*] = *Platismatia lacunosa* (Ach.) Culb. & C.Culb.
lacunosa Elenkin [*Cetraria*] = *Asahinea chrysantha* (Tuck.) Culb. & C.Culb.
lacunosa Th.Fr. [*Cetraria*] = *Platismatia norvegica* (Lynge) Culb. & C.Culb.
laeteflava Zahlbr. [*Cetraria*] =? *Cetreliopsis rhytidocarpa* (Zahlbr.) Lai
59. *laevigata* Rassad. [*Cetraria*] = *Cetraria laevigata* Rassad.
lanata (Necker) Schaerer [*Cetraria*] = *Pseudephebe pubescens* (L.) M.Choisy
60. *laureri* Krempelh. [*Cetraria*] = *Nephromopsis laureri* (Krempelh.) Kurok.
*61. *laxa* (Zahlbr.) Sato [*Cetraria*] = *Nephromopsis laxa* (Zahlbr.) Sato
*62. *leucostigma* Lev. [*Cetraria*] = *Cetraria leucostigma* Lev.
libertina Stuckenb. [*Cetraria*] = *Cetraria ericetorum* Opiz
madreporiformis (Ach.) Müll.Arg. [*Cetraria*] = *Dactylina madreporiformis* (Ach.) Tuck.
magnussonii Llano [*Cetraria*] = *Cetraria nigricascens* (Nyl. in Norrl.) Elenkin
megaleia (Nyl.) Räsänen [*Cetraria*] = *Cetrelia sanguinea* (Schaerer) Culb. & C.Culb.
*63. *melaloma* Krempelh. [*Cetraria*] = *Cetraria melaloma* Krempelh.
*64. *merrillii* Du Rietz [*Cetraria*] = *Tuckermannopsis merrillii* (Du Rietz) Hale
?65. *microphylla* Elenkin [*Cetraria*]
66. *microphyllica* Culb. & C.Culb. [*Cetraria*] = *Tuckermannopsis microphyllica* (Culb. & C.Culb.) Lai
67. *monachorum* Zahlbr. [*Parmelia*] = *Cetrelia monachorum* (Zahlbr.) Culb. & C.Culb.
68. *morrisonicola* Lai [*Nephromopsis*] = *Nephromopsis morrisonicola* Lai
muricata (Ach.) Eckf.[*Cetraria*] = *Coelocaulon muricatum* (Ach.) Laundon
69. *nepalensis* Awasthi [*Cetraria*] = *Cetraria nepalensis* Awasthi
nephromoides (Nyl.) Vainio [*Cetraria*] = *Nephromopsis ectocarpisma* (Hue) Gyelnik
70. *nigricans* Nyl. [*Cetraria*] = *Cetraria nigricans* Nyl.
71. *nigricascens* (Nyl. in Norrl.) Elenkin [*Cetraria*] = *Cetraria nigricascens* (Nyl. in Norrl.) Elenkin
nipharga (Ach.) Röhling = *Allocetraria cucullata* (Bellardi) Randl. & Saag
72. *nipponensis* (Asah.) Culb. [*Cetraria*] = *Nephromopsis nipponensis* (Asah.) Lai

73. *nivalis* (L.) Ach. [*Cetraria*] = *Allocetraria nivalis* (L.) Randl. & Saag
normoerica (Gunn.) Lynge [*Cetraria*] = *Cornicularia normoerica* (Gunn.) Du Rietz
74. *norvegica* (Lynge) Du Rietz [*Cetraria*] = *Platismatia norvegica* (Lynge) Culb. & C.Culb.
?75. *nova-zelandiae* Zahlbr. [*Cetraria*]
76. *nuda* (Hue) Culb. & C.Culb. [*Cetrelia*] = *Cetrelia nuda* (Hue) Culb. & C.Culb.
*77. *oakesiana* Tuck. [*Cetraria*] = *Tuckermannopsis oakesiana* (Tuck.) Hale
ochrocarpa (Eggerth) Lettau [*Cetraria*] {nomen invalidum} = *Tuckermannopsis oakesiana* (Tuck.) Hale
78. *odontella* (Ach.) Ach. [*Cetraria*] = *Cetraria odontella* (Ach.) Ach.
79. *olivetorum* Nyl. [*Parmelia*] = *Cetrelia olivetorum* (Nyl.) Culb. & C.Culb.
80. *orbata* (Nyl.) Fink [*Cetraria*] = *Tuckermannopsis orbata* (Nyl.) Lai
81. *orientalis* Randl. & Saag [*Cetrelia*] = *Cetrelia orientalis* Randl. & Saag
82. *ornata* Müll.Arg. [*Cetraria*] = *Nephromopsis ornata* (Müll.Arg.) Hue
pachysperma (Hue) Zahlbr. [*Cetraria*] = *Parmelaria thomsonii* (Stirton) Awasthi
83. *pallescens* Schaerer [*Cetraria*] = *Nephromopsis pallescens* (Schaerer) Park
pallida Awasthi [*Cetraria*] = *Cetraria melaloma* Krempelh.
*84. *pallidula* Tuck. ex Riddle [*Cetraria*] = *Tuckermannopsis pallidula* (Tuck. ex Riddle) Hale
perstraminea Zahlbr. [*Cetraria*] = *Nephromopsis komarovii* (Elenkin) Wei
85. *pinastri* (Scop.) Gray [*Cetraria*] = *Vulpicida pinastri* (Scop.) J.-E.Mattsson & Lai
placorodia (Ach.) Tuck. [*Cetraria*] = *Imshaugia placorodia* (Ach.) S.F.Meyer
platyna Ach. [*Cetraria*] = *Cetraria islandica* (L.) Ach.
*86. *platyphylla* Tuck. [*Cetraria*] = *Tuckermannopsis platyphylla* (Tuck.) Hale
87. *platyphylloides* (Asah.) Sato [*Cetraria*] = *Tuckermannopsis platyphylloides* (Asah.) Lai
polyschiza (Nyl.) Jatta [*Cetraria*] = *Cetraria hepatizon* (Ach.) Vainio
88. *potaninii* Oxner [*Cetraria*] = *Allocetraria potaninii* (Oxner) Randl. & Saag
89. *pseudocollata* Randl. & Saag [*Cetrelia*] = *Cetrelia pseudocollata* Randl. & Saag
90. *pseudocomplicata* Asah. [*Cetraria*] = *Nephromopsis pseudocomplicata* (Asah.) Lai
91. *pseudolivetorum* Asah. [*Parmelia*] = *Cetrelia pseudolivetorum* (Asah.) Culb. & C.Culb.
pubescens (L.) Desport. [*Cetraria*] = *Pseudephebe pubescens* (L.) M.Choisy
ramulosa (Hook.) Tuck. [*Cetraria*] = *Dactylina ramulosa* (Hook.) Tuck.
92. *rassadinae* Makryi [*Cetraria*] = *Cetraria rassadinae* Makryi
93. *regenerans* Culb. & C.Culb. [*Platismatia*] = *Platismatia regenerans* Culb. & C.Culb.
reticulata Krempelh. [*Cetraria*] {nomen nudum} = *Platismatia erosa* Culb. & C.Culb.
rhizophora (Vainio) Rassadina [*Cetraria*] = *Cetraria nigricascens* (Nyl. in Norrl.) Elenkin

*94. *rhytidocarpa* Mont. & v.d.Bosch [*Cetraria*] = *Cetreliopsis rhytidocarpa* (Mont. & v.d.Bosch) Lai

95. *richardsonii* Hook. in Richardson [*Cetraria*] = *Masonhalea richardsonii* (Hook. in Richardson) Kärnef.

rubescens (Th.Fr.) Vainio [*Parmelia*] = *Cetrelia olivetorum* (Nyl.) Culb. & C.Culb.

96. *rugosa* (Asah.) Sato [*Cetraria*] = *Nephromopsis rugosa* Asah.

97. *sanguinea* Schaerer [*Cetraria*] = *Cetrelia sanguinea* (Schaerer) Culb. & C.Culb.

saviczii Oxner & Rassad. [*Cetraria*] = *Asahinea scholanderi* (Llano) Culb. & C.Culb.

98. *scholanderi* Llano [*Cetraria*] = *Asahinea scholanderi* (Llano) Culb. & C.Culb.

scutata (Wulf.) Poetsch [*Cetraria*] = *Tuckermannopsis sepincola* (Ehrh.) Hale

scutata auct. [*Cetraria*] = *Tuckermannopsis chlorophylla* (Willd.) Hale

*99. *sepincola* (Ehrh.) Ach. [*Cetraria*] = *Tuckermannopsis sepincola* (Ehrh.) Hale

septentrionalis (Nyl.) Almq. [*Cetraria*] = *Asahinea chrysantha* (Tuck.) Culb. & C.Culb.

sibirica Magnusson [*Cetraria*] = *Cetraria nigricascens* (Nyl. in Norrl.) Elenkin

sikkimensis Räsänen [*Cetraria*] = *Cetraria leucostigma* Lev.

simmonsii Krog [*Cetraria*] = *Cetraria andrejevii* Oxner

100. *sinensis* Culb. & C.Culb. [*Cetrelia*] = *Cetrelia sinensis* Culb. & C.Culb.

sorediella (Lettau) Rico & Manrique [*Cetraria*] {nomen nudum} = *Cetraria commicta* f. *sorediella* Lettau

101. *sphaerosporella* Müll.Arg. [*Parmelia*] = *Ahtiana sphaerosporella* (Müll.Arg.) Goward

102. *stenophylla* (Tuck.) G.K.Merr. [*Cetraria*] = *Platismatia stenophylla* (Tuck.) Culb. & C.Culb.

103. *stracheyi* Bab. [*Evernia*] = *Allocetraria stracheyi* (Bab.) Kurok. & Lai

104. *stracheyi* Bab. [*Cetraria*] = *Nephromopsis stracheyi* (Bab.) Müll.Arg.

?105. *straminea* Krempelh. [*Cetraria*]

straminea Vainio [*Cetraria*] {nom. illegit} =? *Cetreliopsis rhytidocarpa* (Mont. & v.d.Bosch) Lai

stuppea Flotow ex Sandst. = *Coelocaulon muricatum* (Ach.) Laundon

stygia (L.) Schaerer [*Cetraria*] = *Melanelia stygia* (L.) Essl.

*106. *subalpina* Imsh. [*Cetraria*] = *Cetraria subalpina* Imsh.

*107. *subfendleri* Essl. [*Cetraria*] = *Cetraria subfendleri* Essl.

subperlatum Nyl. [*Platysma*] = *Cetrelia sanguinea* (Schaerer) Culb. & C.Culb.

*108. *subscutata* Lindsay [*Cetraria*] = *Cetraria subscutata* Lindsay

109. *subthomsonii* Awasthi [*Parmelaria*] = *Parmelaria subthomsonii* Awasthi

sulphurea Mont. [*Cetraria*] =? *Nephromopsis pallescens* (Schaerer) Park

tenuifolia (Retz.) R.H.Howe [*Cetraria*] = *Cetraria ericetorum* Opiz

tenuissima (L.) Vainio [*Cetraria*] = *Coelocaulon aculeatum* (Schreber) Link

terrestris (Schaerer) Fink [*Cetraria*] = *Vulpicida tilesii* (Ach.) J.-E.Mattsson & Lai

teysmanni Mont. & v.d.Bosch [*Cetraria*] =? *Nephromopsis pallescens* (Schaerer) Park

110. *thomsonii* (Stirton) Müll.Arg. [*Cetraria*] = *Parmelaria thomsonii* (Stirton) Awasthi
thyreophora (Ach.) Röhl. [*Cetraria*] = *Cetraria islandica* (L.) Ach.
111. *tilesii* Ach. [*Cetraria*] = *Vulpicida tilesii* (Ach.) J.-E.Mattsson & Lai
*112. *togashii* Asah. [*Cetraria*] = *Cetraria togashii* Asah.
tristis (Weber) Fr. [*Cetraria*] = *Cornicularia normoerica* (Gunn.) Du Rietz
113. *tubulosa* (Schaerer) B.de Lesd. [*Cetraria*] = *Vulpicida tubulosus* (Schaerer) J.-E.Mattsson & Lai
tuckermanii Herre [*Cetraria*] {nom. illegit.} = *Platismatia herrei* (Imsh.) Culb. & C.Culb.
tuckermanii R.H.Howe [*Cetraria*] {nom. illegit.} = *Tuckermannopsis merrillii* (Du Rietz) Hale
114. *tuckermanii* Oakes [*Cetraria*] = *Platismatia tuckermanii* (Oakes) Culb. & C.Culb.
ulophylla (Ach.) Rebent. [*Cetraria*] = *Tuckermannopsis chlorophylla* (Willd.) Hale
*115. *ulophylloides* Asah. [*Cetraria*] = *Tuckermannopsis ulophylloides* (Asah.) Lai
urceolata (Eschw.) Mont. [*Cetraria*] = *Parmotrema* sp.
116. *viridis* Schwein. [*Cetraria*] = *Vulpicida viridis* (Schwein.) J.-E.Mattssom & Lai
wallichiana (Taylor) Lai [*Ahtia* - nom. illegit.] = *Cetrariopsis wallichiana* (Taylor) Kurok.
117. *wallichiana* (Taylor) Müll.Arg. [*Cetraria*] = *Cetrariopsis wallichiana* (Taylor) Kurok.
*118. *weberi* Essl. [*Cetraria*] = *Cetraria weberi* Essl.
?119. *xizangensis* Wei & Jiang [*Cetraria*]
120. *yunnanensis* Zahlbr. [*Cetraria*] = *Nephromopsis yunnanensis* (Zahlbr.) Randl. & Saag

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LITERATURE CITED

Awasthi, D.D. 1987. A new position for *Platysma thomsonii* Stirton. Journ. Hattori Bot. Lab. 63: 367-372.

Culberson,W.L. & Culberson, C.F. 1965. *Asahinea*, a new genus in the Parmeliaceae. Brittonia 17: 182-190.

Culberson, W.L. & Culberson, C.F. 1968. The lichen genera *Cetrelia* and *Platismatia* (Parmeliaceae). Contr. U.S. Natl.Hern.: 449-558.

Egan, R.S. 1987. A fifth checklist of the lichen-forming, lichenocolous and allied fungi of the continental United States and Canada. Bryologist 90: 77-173.

Goward, T. 1985. *Ahtiana*, a new lichen genus in the Parmeliaceae. Bryologist 88: 367-371.

Gyelnik, V. 1931. Additamenta ad cognitionem lichenum extraeuropaeorum. Ann. Cryptog. Exot. 4: 166-174.

Gyelnik, V. 1933. Lichenes varii novi critique. Acta Fauna et Flora Univ. 1: 3-10.

Kärnefelt, I. 1977. *Masonhalea*, a new lichen genus in the Parmeliaceae. Bot. Notiser 130: 101-107.

Kurokawa, S. 1980. *Cetrariopsis*, a new genus in the Parmeliaceae, and its distribution. Mem.Natn. Sci. Mus. 13: 139-142.

Kurokawa, S. & Lai, M.J. 1991. *Allocetraria*, a new lichen genus in the Parmeliacea. Bull. Natn. Sci. Mus. 17: 59-65.

Lai, M.J. 1980. Studies on the cetrarioid lichens in Parmeliaceae of East Asia. Quart. Journ. Taiwan Museum 33: 215-229.

Mattsson, J.-E. & Lai, M.-J. 1993. *Vulpicida*, a new genus in Parmeliaceae (lichenized Ascomycetes). Mycotaxon 46: 425-428.

Müller Argoviensis, J. 1891. Lichenes Miyoshiani in Japonia a cl. Miyoshi lecti et a cl. Professore Yatabe communicati. Nuov. Giorn. Bot. Ital. 23: 120-131.

Rassadina, K.A. 1950. *Cetraria* in the U.S.S.R. Plantae Cryptogamae, 5: 171-304 (in Russian).

Räsänen, V. 1952. Studies on the species of the lichen genera *Cornicularia*, *Cetraria* and *Nephromopsis*. Kuopion Luonnon Ystäväin Yhdistyksen Julkaisuja B 2: 1-53.

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TWO NEW SPECIES OF CRISTINIA (BASIDIOMYCOTINA, APHYLLOPHORALES) AND A SURVEY OF THE GENUS

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Two new species of *Cristinia* Parm. are described viz. ***C. brevicellularis*** Hjortst. and ***C. rhenana*** Grosse-Brauckmann. A new combination ***Cristinia coprophila*** (Wakef.) Hjortst. is proposed. The genus ***Dacryobasidium*** Jülich is considered as a synonym of ***Cristinia***. A key to the species of ***Cristinia*** is offered.

INTRODUCTION

Cristinia Parm. with the generic type *Hydnum helveticum* Pers., is a genus well characterized by a rather loose basidiome, occurrence of hyphal strands and above all with cyanophilous granulation in the basidia and thick-walled, cyanophilous basidiospores. The genus was originally introduced with two species, the second being *C. sasae* Parm. which, however, was later synonymized with *C. helvetica* by Baici and Hjortstam (1984).

CRISTINIA Parm. Consp. syst. corticiacearum p. 47 (1968).
BASIDIOMES resupinate, effused,loosely attached to the substratum.
HYMENOPHORES hypochnoid, mucedinioid, smooth to grandinioid, more rarely odontioid or raduloid, hyphal strands occur regularly in the periphery.
HYPHAL SYSTEM monomitic; hyphae thin-walled or with slight wall thickening, mostly short-celled at least in the subhymenial layer, with or without clamp-connexions or sometimes with scattered clamps on the subicular hyphae.
CYSTIDIA absent.
BASIDIA fairly short (15–25 µm), subclavate to cylindrical, slightly constricted, with four sterigmata and a distinct cyanophilous granulation in the protoplasm.
SPORES fairly uniform, almost globose to subglobose and often slightly angular, 4–7 µm diam., smooth, moderately thick-walled to distinctly thick-walled and cyanophilous, not amyloid or dextrinoid.

KEY TO SPECIES OF *CRISTINIA*

1. Clamp-connexions absent 2
1. Clamp-connexions present throughout, scattered or absent on the subicular hyphae 3
    2. Hymenophore distinctly grandinioid, basal hypae 4–6 µm wide. Europe. . . . . *C. artheniensis*

2. Hymenophore smooth to slightly grandinioid, basal hyphae 8–10 µm wide. Brazil. . . . . *C. brevicellularis*
3. Hymenophore raduloid to irpicoid. An uncommon species. Holarctic . . *C. gallica*
3. Hymenophore smooth to grandinioid 4
4. Hymenophore grandinioid, all hyphae with clamp-connexions, spores 4.5–5 µm broad. A rather common species. Cosmopolitan (?) . . . . *C. helvetica*
4. Hymenophore for the most part smooth, basal hyphae either without or with scattered clamp-connexions 5
5. Hymenophore normally with a violet tint in KOH, basal hyphae with scattered clamp-connexions, spores 5–7 µm diam. Known from Germany only . . . . *C. rhenana*
5. Hymenophore without a violet reaction in KOH, basal hyphae without clamp-connexions, spores 4–5 µm diam. England, additional records not known . *C. coprophila*

SPECIES

1. **CRISTINIA ARTHENIENSIS** Baici & Hjortst. in Sydowia, Annls Mycol. Ser.II, 37:11 (1984).

2. **CRISTINIA BREVICELLULARIS** Hjortst. nov. sp.
Basidioma resupinatum, plus minus laxe adnatum, farinosum vel hypochnoideum. Hymenium fere leve vel leviter grandinioideum, pallide isabellinum. Margo simillimus. Systema hyphale monomiticum; totis hyphis efibulatis. Hyphae basales rectae, laxe intertextae, tenuitunicatae, plus minus hyalinae, 8–10 µm latae; hyphae subhymeniales brevicellulares, 5–8 µm latae. Hypharum fila presentes; hyphis tenuitunicatis vel crassiusculis, pallide ochraceis, 5–8 µm latis. Cystidia nulla. Basidia subcylindracea, leviter constricta, 15–18 × 6–7 m, 4 sterigmatibus. Sporae subglobosae, leves, moderate crassitunicatae, circiter 5 × 4 m, neque amyloideae, neque dextrinoideae, distincte cyanophilae.

Holotypus: Brazil, Sao Paulo, Santos, Cananeia, Ilha do Cardoso, on deciduous wood, 2–5 Feb. 1987, Hjortstam 16753 (K).

Isotypus: (GB).

BASIDIOME resupinate, loosely adnate, farinaceous to hypochnoid.
HYMENOPHORE smooth to slightly grandinioid, pale isabelline. Hyphal strands present in the periphery, with individual hyphae 5–8 µm wide, pale ochraceous. Margin indeterminate.
HYPHAL SYSTEM monomitic; basal hyphae straight, branched at more or less right angles, thin-walled, hyaline, 8–10 µm wide; subhymenial hyphae short-celled, almost isodiametric and with septa at 5–15 µm intervals, 5–8 µm wide; all hyphae without clamp-connexions.

CYSTIDIA absent.
BASIDIA subcylindric, with a distinct cyanophilous granulation, slightly constricted in the middle part, 15–18 × 6–7 m, with four sterigmata, lacking a basal clamp-connexion.
SPORES subglobose, moderately thick-walled (KOH), smooth, about 5 × 4 m, inamyloid, indextrinoid, strongly cyanophilous.

This is a typical species of *Cristinia* and is superficially similar to *C. artheniensis* Baici & Hjortst. which also lacks clamp-connexions. The latter species, however, has a grandinioid hymenophore and narrower hyphae.

3. **CRISTINIA COPROPHILA** (Wakef.) Hjortst. nov. comb.

Basionym: *Corticium coprophilum* Wakef. in Trans. Br. mycol. Soc. 6:480 (1916).

Holotype: England. On dung, beds near Temp. House, Kew, 5 July, 1912, Wakefield (K)!

This species is characterized by a nearly smooth and pale yellow hymenophore with hyphal strands in the periphery. The basal hyphae are without clamp-connexions, but the subhymenial ones regularly bearing clamps. The basidia are about 20–25 × 5.5–6.5 m, more or less subclavate and with a distinct cyanophilous granulation. All basidia are provided with a basal clamp-connexion and the spores are 4–5 µm diam., thick-walled and distinctly cyanophilous.

The species was reported by Jülich (1972 and 1984) to be distributed in England (type-locality), Germany, The Netherlands, Sweden and also in Canada and USA. Except for the type no other specimens have been examined. The specimen from Sweden (Småland, Almesåkra) represents *Byssocorticium lutescens* Erikss. & Ryv. and is the holotype of this species and preserved in TRTC!

For illustration of *Byssocorticium coprophilum* and comments of *B. lutescens* see Eriksson and Ryvarden (1973).

Jülich (1981) described the genus *Dacryobasidium*, with *Corticium coprophilum* Wakef. as type besides *Byssocorticium lutescens* Erikss. & Ryv. The latter lacks the basidial cyanophilous granulation, and the morphology of the basidia as well as that of the spores is more reminiscent of *Hypochniciellum* Hjortst. & Ryv. Also *Amphinema* Karst. and *Piloderma* Jülich should be considered, as the basidia are basally narrowed and more or less pedunculate. The species is, however, at present maintained in *Byssocorticium.* Consequently, the genus *Dacryobasidium* Jülich is here considered as a synonym of *Cristinia* Parm.

4. **CRISTINIA GALLICA** (Pilát) Jülich in Persoonia 8:298 (1975)

Radulum gallicum Pilát in Mykologia 2:54 (1925); *Cristinia mucida* Erikss.& Ryv. nom.nov. Corticiaceae North Eur. 3:311 (1975).

Radulum mucidum (Pers.) sensu Bourd. & Galz.in Bull. trimest. Soc. mycol. Fr. 30:247–248 (1914); non *Hydnum mucidum* Pers.:Fr. Syst. Mycol. 1:418 (1821) = *Dentipellis fragilis* (Pers.:Fr.) Donk; non *Hydnum mucidum* Pers. Mycol. Europ. 2:179 (1825) = *Trechispora farinacea* (Pers.:Fr.) Liberta.

For illustration and description (sub *Cristinia mucida*) see Eriksson and Ryvarden (1975). See further Jülich (op.cit.) for a nomenclatural discussion about *Cristinia mucida* Erikss.& Ryv.

5. **CRISTINIA HELVETICA** (Pers.) Parm. in Consp. syst. corticiacearum p. 48 (1968)

Hydnum helveticum Pers. Mycol. Eur. 2:184 (1825).

For description and illustration of the species see Eriksson and Ryvarden (op.cit.).

6. **CRISTINIA RHENANA** Grosse-Brauckmann nov. sp. fig. 1

Basidioma resupinatum, laxe adherens, cremeum. Hymenium leve; margine fibrilloso cum rhizomorphis subtilibus. Systema hyphale monomiticum, hyphae subhymeniales omnes fibulatae, tenuiter tunicatae, 3.5–5 µm latitudine. Hyphae basales fibulatae vel efibulatae, latitudine 4–7(–9) m. Cystidia nulla. Basidia subclavata vel subcylindrata, (20–)25–35(–50) × (6–)6.5–7.5 m, 4 sterigmatibus. Protoplasma basidiorum cum guttulis oleosis cyanophilis.

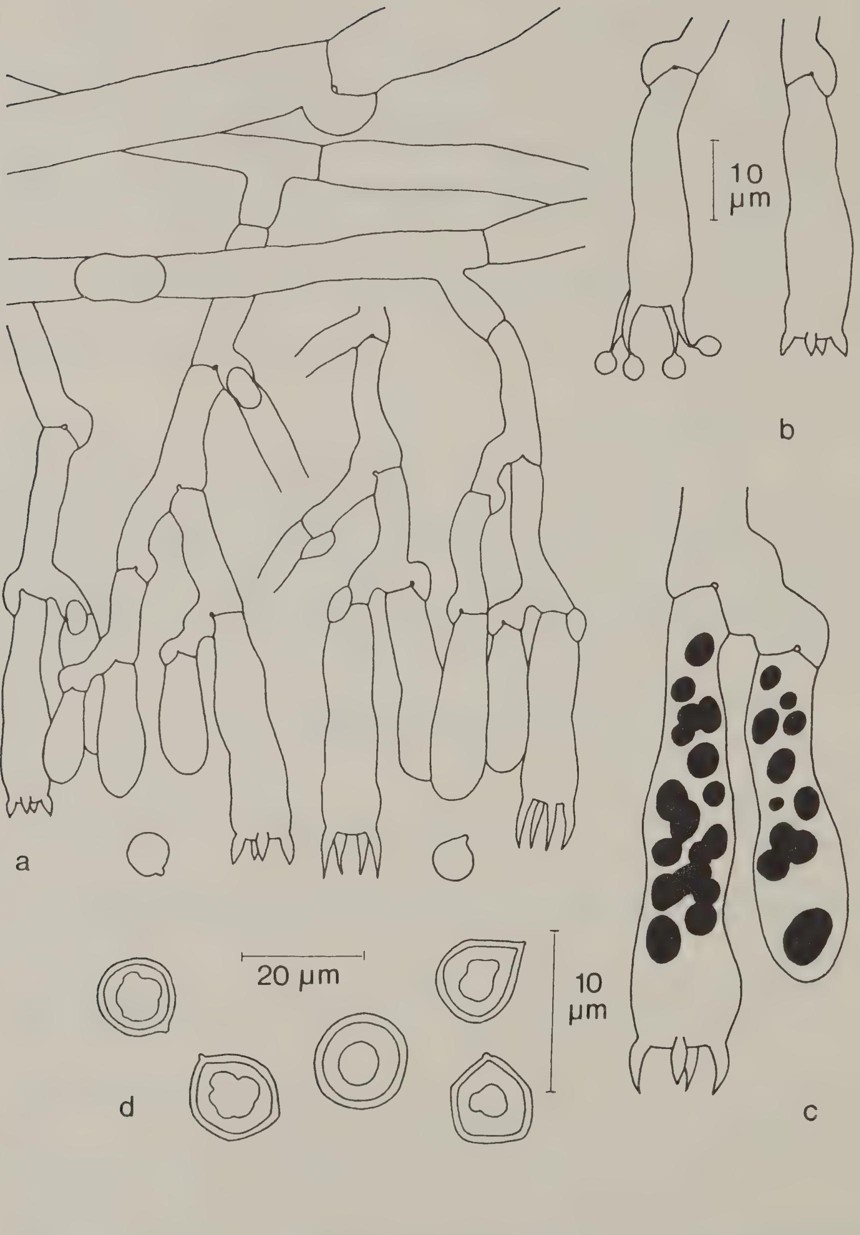
a
b
c
d
10 µm
20 µm
10 µm

Fig. 1. *Cristinia rhenana.* a) section through part of the basidiome b) basidia c) young basidia with cyanophilous granulation d) spores. — From the holotype.

Sporae globosae vel obovatae, nonnumquam leviter angulatae, leves, cyanophilae, neque amyloideae, neque dextrinoideae, incrassate tunicatae, diametro (4–)5–6.5(–7) m.

Holotypus: Germany, Hessen, Oberrheinebene, Nature Reserve "Kühkopf", on Populus nigra, 8 Jan. 1988, H. Grosse-Brauckmann 3696 (GB).

Paratypi: Germany, Hessen, Oberrheinebene, Nature Reserve "Kühkopf", on Populus nigra, 31 Dec. 1988, H. Grosse-Brauckmann 4351; Rheinland-Pfalz, Oberrheinebene near Mannheim, "Maudacher Bruch", on Acer, 28 Dec. 1987, leg. U. Sauter. Duplicate H. Grosse-Brauckmann 4371. All specimens in Grosse-Brauckmann's priv. Herb.

BASIDIOME resupinate, effused, loosely attached to the substratum, soft, when fresh whitish grey, in dried state cream-coloured, with thin hyphal strands in the subiculum and in the periphery, margin indistinctly fibrillose.
HYMENOPHORE at first reticulate, then continuous and smooth, in KOH normally with a violet tint.
HYPHAL SYSTEM monomitic; subhymenial hyphae indistinctly short-celled, thin-walled, with clamp-connexions at all septa, 3.5–5 µm wide; subicular hyphae somewhat thick-walled and with scattered, mostly large clamp-connexions, 4–7(–9) µm wide.
CYSTIDIA absent.
BASIDIA subclavate to subcylindrical, (20–)25–35(–50) × (6–)6.5–7.5 m, with oily contents in the protoplasm and normally with four sterigmata, with a basal clamp-connexion. Immature basidia with cyanophilous granulation.
SPORES globose to ovoid, now and then somewhat angular, with a small, but distinct apiculus, smooth, thick-walled, inamyloid, indextrinoid, but distinctly cyanophilous, mostly uniguttulate, (4–)5–6.5(–7) µm diam.

The species is characterized by an almost smooth basidiome and scattered clamp-connexions on the subicular hyphae. Further, the violet tint with KOH is distinctive.

SPECIES EXCLUDENDAE

Cristinia filia (Bres.) Liberta in Can. Journ. Bot. 51:1891 (1973); *Corticium filium* Bres. in Annls mycol. Berlin, 6:43 (1908).
Lectotype: France, Bourdot no. 6984 (P), designated by Liberta (op. cit.).

This is not a species of *Cristinia* because of the acyanophilous basidial contents and the dextrinoid spores. Nevertheless, we have no suggestion as to its generic position.

Cristinia sonorae Nakas. & Gilb. in Mycologia 70:271–272 (1978).

The holotype, (USA, Arizona, KKN 237), is mixed and comprises two different species, but neither belonging in *Cristinia*. One part is a species of *Hyphodontia* (subsectio *Ellipsosporae* Parm.). This portion of the holotype fits the diagnosis of *C. sonorae* by presence of cystidia and the size of spores, but neither hyphae nor spores are cyanophilous. The second part seems to be a species of *Radulodon* Ryv. and is somewhat reminiscent of *R. americanus* Ryv.

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REFERENCES

Baici, A. and **Hjortstam, K.** 1984. A new species of *Cristinia* (Aphyllophorales, Corticiaceae) from North Italy. Sydowia Ann. Mycol. 37:11–14.

Eriksson, J. and **Ryvarden, L.** 1973. The Corticiaceae of North Europe, Vol. 2. *Aleurodiscus – Confertobasidium.* Fungiflora. Oslo.

— 1975. The Corticiaceae of North Europe, Vol. 3. *Coronicium – Hyphoderma.* Fungiflora. Oslo.

Jülich, W. 1972. Monographie der Athelieae (Corticiaceae, Basidiomycetes). Willdenowia, Beih. 7:1–283.

— 1981. Higher Taxa of Basidiomycetes. Bibliotheca Mycologica 85, 485 pp.

— 1984. Die Nichtblätterpilze, Gallertpilze und Bauchpilze (Aphyllophorales, Heterobasidiomycetes, Gastromycetes). Kleine Kryptogamenflora Band II b/1. Stuttgart New York.

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COMMENTS ON RECENT WORK ON *OPHIOSTOMA* AND ITS SYNNEMATOUS ANAMORPHS

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The following is my reaction to two recent publications on the anamorphs of *Ophiostoma*: Wingfield, M. J., Kendrick, B. and van Wyck, P. S. "Analysis of conidium ontogeny in anamorphs of *Ophiostoma*." Mycological Research 95: 1328-1333, 1991, and Mouton, M., Wingfield, M. J. and van Wyck, P. S. "Conidium development in the synnematous anamorphs of *Ophiostoma*." Mycotaxon 46: 371-379, 1993. As I understand, the objective of these contributions were to study the type species of *Pesotum* Crane & Sckoknecht and of *Phialographium* Upadhyay & Kendrick developmentally in order to compare their conidiogenesis with that which occurs in the type species of *Graphium* Corda. I am satisfied that the analysis that the authors carried out was appropriate to answer the specific question that the authors posed. However, I feel that this question itself is not the most important to raise regarding the taxonomic value of percurrently proliferating conidiogenous cells in three genera, since it is now apparent that the conidiogenous cell growth can no longer be viewed as compartmentalized (Upadhyay, 1981; Minter *et al.*, 1983; Minter, 1987).

Although the authors entitled their paper "Analysis of conidium ontogeny in anamorphs of *Ophiostoma: Pesotum* and *Phialographium* are synonyms of *Graphium*," they delineated, with some justification only two species of *Pesotum, i.e., P. ulmi* (Schw.) Crane & Schoknecht and *P. piceae* Crane & Schoknecht as assigned by Crane and Schoknecht (1973) vs. *Graphium*, but failed to examine the type species of *Phialographium*. The rest of their discussions and decisions with respect to other anamorphs of *Ophiostoma* were apparently based on scrutiny of the literature without examination of types or authentic specimens. In my, *A monograph of Ceratocystis and Ceratocystiopsis* (Upadhyay, 1981, p. 61), I cited a number of cultures and specimens of the *Phialographium* state of *Ceratocystis sagmatospora* Wright & Cain (=*P. sagmatosporae* Upadhyay & Kendrick) which they claimed could not be obtained for EM studies. In my studies, these cultures of the type species of *Phialographium* produced anamorphic and teleomorphic states, including conidiogenous cells with distinct collarettes. I wish also to mention that the *Hyalopesotum* Upadhyay & Kendrick, *Pesotum, Pachnodium* Upadhyay & Kendrick and *Verticicladiella* Hughes anamorphs of *Ceratocystis* and *Ceratocystiopsis*, in my observations under phase contrast photomicroscope, were commonly accompanied by a *Sporothrix*-like morphogenesis in pure culture, either consistently or under certain conditions. Such morphogenesis was never observed in the species of the form-genera *Graphilbum*

Upadhyay & Kendrick, *Leptographium* Lagerberg & Melin, *Phialocephala* Kendrick, or *Phialographium* that I examined. *Ceratocystis ips* (Rumb.) C. Moreau produced a *Graphilbum* anamorph accompanied with *Bainieria*-like morphogenesis in most of the cultures examined. On the other hand, synnematous and penicillately branched mononematous conidiophores often lose fertility in artificial cultures to such an extent that they may produce conidia only on simple conidiophores similar to those of *Sporothrix* Hektoen & Perkins (*Pesotum*-like and *Verticicladiella*-like) and *Bainieria* Arnaud. These monomematous synanamorphs and their conidiation are important issues that also need to be considered relative to the value of anamorph-generic delimitation posed by the authors. Strangely enough, conidiogenous cells of *Pesotum*-like and *Verticicladiella*-like anamorphs only can be discerned as proliferating percurrently by the use of an electron microscope, which may not be feasible for every worker for quick identification of species of these fungi.

Also, I would like to note that the first of these two articles contains two erroneous citations: On page 1331 paragraph 2, the authors state, "Upadhyay and Kendrick (1975) suggested that the conidiogenesis in the synnematous anamorph of *Ophiostoma sparsum* (Davidson) de Hoog & Scheffer was phialidic, and established the segregate anamorph-genus *Graphilbum* Upadhyay & Kendrick as the hyaline analogue of *Phialographium*"; whereas, Upadhyay and Kendrick (1975) clearly characterized and delineated the genus *Graphilbum* as having percurrent, annellidic conidiogenous cells (Mycologia 67: 800) and noted that this genus is a hyaline analogue of *Graphium* (Mycologia 67: 799). Also, on page 1332, on the penultimate line, the authors miscited *Ceratocystis davidsonii* Olchowecki & Reid, Can. J. Bot. 52: 1698 (1974) as "*Ophiostoma davidsonii* Olchowecki & Reid."

One reason that I feel that these issues need to be raised is that the use of conidial ontogeny in delimitation of anamorphic genera is under intense scrtuiny (Minter *et al.* 1982, 1983, 1983, Minter, 1987). In light of present controversy surrounding the use of conidial ontogeny in taxonomy of the ophiostomataceous fungi and their anamorphic genera, the developmental study of types or authentic specimens, preferably by comparing a combination of features of all closely related anamorphs and teleomorphs, is necessary in order to understand and delineate the holomorph more broadly than narrower definitions favored by Wingfield *et al.* For more detail, see Upadhyay (1981, 1992)

Dr. Richard A. Humber, USDA-ARS, Ithaca, NY, critically reviewed that manuscript, for which I am grateful. Dr. Leonor C. Maia of this Department kindly read the manuscript.

LITERATURE CITED

Crane, J. L. and J. D. Schoknecht. 1973. Conidiogenesis in *Ceratocystis ulmi, Ceratocystis piceae*, and *Graphium penicilloides*. Am. J. Bot. 60: 346-354.

Minter, D. W., P. M. Kirk and B. C. Sutton. 1982. Holoblastic phialides. Trans. Br. Mycol. Soc. 79: 75-93.

Minter, D. W., P. M. Kirk and B. C. Sutton. 1983. Thallic phialides. Trans. Br. Mycol. Soc. 80: 36-66.

Minter, D. W., B. C. Sutton and B. L. Brady. 1983. What are phialides anyway? Trans. Br. Mycol. Soc. 81: 109-120.

Minter, D. W. 1987. The significance of conidiogenesis in pleoanamorphy. Pages 241-262 in: *Pleomorphic fungi*. J. Sugiyama, ed. Kodansha, Tokyo and Elsevier, Amsterdam.

Upadhyay, H. P. and W. B. Kendrick. 1975. Prodromus for a revision of *Ceratocystis* (Microascales, Ascomycetes) and its conidial states. Mycologia 67: 798-805.

Upadhyay, H. P. 1981. A monograph of *Ceratocystis* and *Ceratocystiopsis*. Univ. Georgia Press: Athens, GA.

Upadhyay, H. P. 1993. Classification of the Ophiostomatalean Fungi. In: *Ceratocystis and Ophiostoma: Biology, Taxonomy, Ecology and Pathology.* M. J. Wingfield, K. A. Seifert and J. Weber, eds. American Phytopathological Society Press. (in press).

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TREMATOSPHAERIA PACHYCARPA AND HERBAMPULLA CRASSIROSTRIS GEN. ET SPEC. NOV. (ASCOMYCETES)

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Botanamphora NOGRASEK & SCHEUER is a nomenclatural synonym of *Trematosphaeria* FUCKEL. The unitunicate pyrenomycete described by NOGRASEK & SCHEUER as *Botanamphora pachycarpa* (SACC. & Él. MARCHAL) NOGRASEK & SCHEUER is not identical with the type material of *Leptosphaeria pachycarpa* SACC. & Él. MARCHAL which has bitunicate asci and belongs to the genus *Trematosphaeria*. Both fungi are redescribed and illustrated. *Herbampulla crassirostris* gen. et spec. nov. is described to accommodate the unitunicate taxon.

Key words: *Botanamphora pachycarpa*, *Leptosphaeria hazslinskyana*, Melanommataceae, Dothideales s.l., Melogrammataceae, Diaporthales s.l.

The genus *Botanamphora* NOGRASEK & SCHEUER (in NOGRASEK 1990: 50) is based on the type of *Leptosphaeria pachycarpa* SACC. & Él. MARCHAL which has been illustrated by BERLESE (1894: 78 and Tab. LXVI/3). NOGRASEK & SCHEUER (l.c.) reported collections from the Eastern Alps containing a very peculiar pyrenomycete with unitunicate asci which they referred to *Leptosphaeria pachycarpa*. The type material of this taxon was not available from PAD at that time, consequently the authors had to rely on BERLESE 's drawings of ascus and ascospores for the new combination. *Trematosphaeria pachycarpa* (SACC. & Él. MARCHAL) SHOEMAKER & BABCOCK (1989: 1595) is another combination based only on BERLESE's figure. Furthermore, SHOEMAKER & BABCOCK synonymized *Leptosphaeria hazslinskyana* BERLESE (1894: 78 and Tab. LXVII/1) with *T. pachycarpa*. So far, the type material of *L. hazslinskyana* could not be located in any herbarium.

The material of the SACCARDO collection in PAD has recently become available on loan again. The type specimen of *Leptosphaeria pachycarpa* has clearly bitunicate asci and the combination proposed by SHOEMAKER & BABCOCK (1989) is most probably correct. Consequently, *Botanamphora* becomes a taxonomic synonym of *Trematosphaeria*, and the unitunicate species which has been misidentified as *Leptosphaeria pachycarpa* by NOGRASEK & SCHEUER (l.c.) needs a new name.

Trematosphaeria pachycarpa (SACC. & Él. MARCHAL) SHOEMAKER & BABCOCK, Canad. J. Bot. 67: 1595 (1989).

Basionym: *Leptosphaeria pachycarpa* SACCARDO & Él. MARCHAL, Rev. Mycologique, Toulouse, 7: 145 (1885).

Synonyms: *Botanamphora pachycarpa* (SACC. & Él. MARCHAL) NOGRASEK & SCHEUER in NOGRASEK, Biblioth. Mycol. 133: 51 (1990), sensu SACC. & Él. MARCHAL, non NOGRASEK & SCHEUER.

? *Leptosphaeria hazslinskyana* BERLESE, Icones Fungorum I, p. 78 and Tab. LXVII/1 (1894).

Other descriptions (sub *Leptosphaeria p.*): SACCARDO, Syll. Fung. IX: 792 (1891); BERLESE, Icones Fung. I: p. 78 and Tab. LXVI/3 (1894).

Ascomata (pseudoperithecia) clustered or single, immersed to almost fully erumpent, subepidermal, black, globose to laterally compressed, ca. 300-450 µm in diam., with or without a rather broad, indistinct ostiolar papilla. Peridium of variable thickness in the lower, immersed part of the ascoma, often including ± unaltered pieces of the substrate's sclerenchyma, consisting of several layers of angular, sometimes slightly flattened cells of extremly variable size and shape (cf. Fig. 1). In the erumpent part of the ascoma the peridium is thicker, especially around the ostiole, with rather irregular, blackish-brown cell wall thickenings in the outer layers. Interascal filaments rather stiff, anastomosing ('trabeculate') up to 2.5 µm thick in younger ascomata with few mature asci, ca. 1 µm thick between the asci of mature ascomata, apparently embedded in a gel matrix, richly branching and loosely interwoven in the upper part. Asci bitunicate (fissitunicate), eight-spored, cylindric-clavate, ca. 140 x 16-18 µm, seated on a basal layer of compact, small-celled, hyaline plectenchyma inserted between the basal part of the peridium and the centrum. The individual cells of the plectenchyma are flattened in longitudinal section and apparently sometimes slightly interwoven. Croziers not seen. Ascospores fusiform, ca. 40-52 x 7.5-10 µm, 5-septate (2:3:1:3:2), brown with pale end cells; primary septum median.

Material examined: *Leptosphaeria pachycarpa* 'SACC.', in culmis graminum majorum in Belgio (Él. MARCHAL: Cryptogames de Belgique, Reliquiae Westendorpi no. 86; Holotypus, PAD).

The accommodation of *Leptosphaeria pachycarpa* in the genus *Trematosphaeria* is accepted here because of the pallid end cells of the ascospores and the rather stiff, anastomosing ('trabeculate') and apically branched interascal filaments which are apparently embedded in a gel matrix.

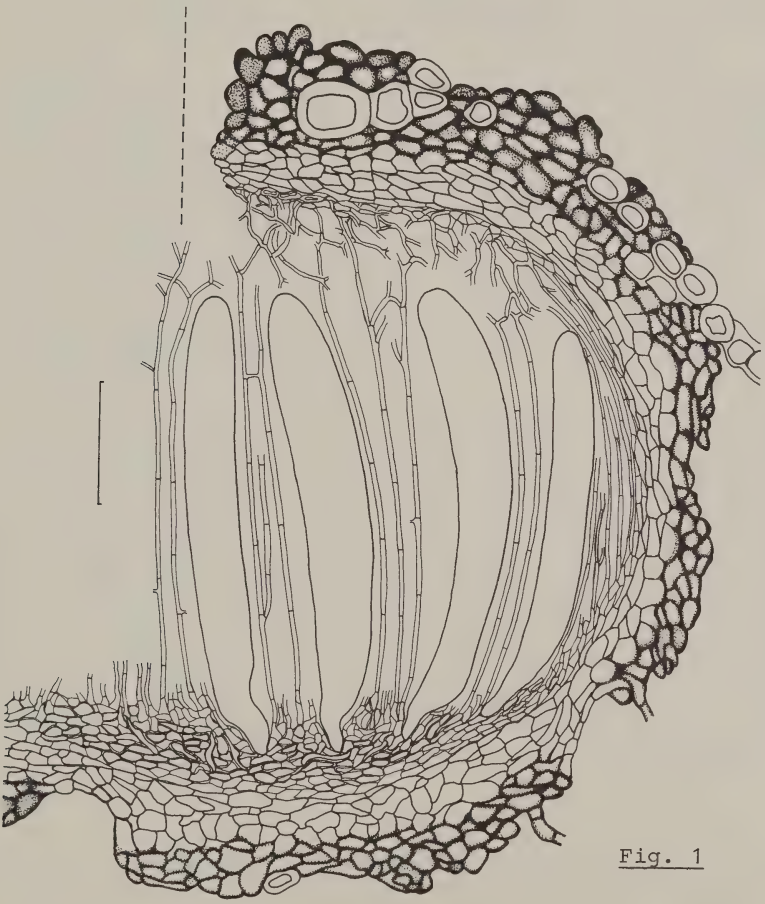

Fig. 1

Fig. 1. *Trematosphaeria pachycarpa*: Longitudinal section of ascoma (Holotypus, lactophenol permanent slide). Bar = 50 µm.

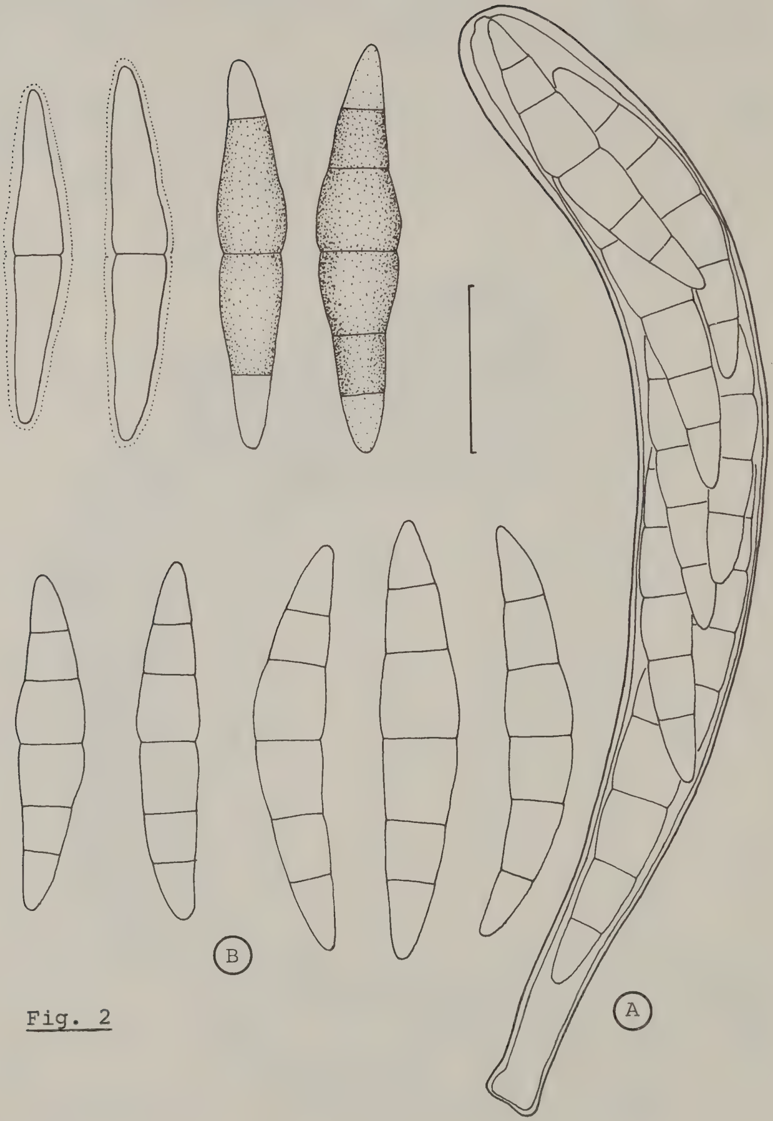

Fig. 2

Fig. 2. *Trematosphaeria pachycarpa*: (A) Ascus. (B) Ascospores. (Holotypus, lactophenol permanent slide). Bar = 20 μm.

Herbampulla SCHEUER & NOGRASEK gen. nov.

Earlier description: sub *Botanamphora* NOGRASEK & SCHEUER in NOGRASEK, Biblioth. Mycol. 133: 50 (1990).
Fam. ?Melogrammataceae, ord. Diaporthales

Typus generis: *Herbampulla crassirostris* SCHEUER & NOGRASEK, vide infra.

Etymology : lat. *herba* = grass (referring to the substrate)
lat. *ampulla* = bottle (referring to the shape of the perithecia); literal translation of the Greek name *Botanamphora*.

Perithecia solitaria, in graminibus emortuis crescentia, substrato immersa, ampulliformia. Peridium in parte externa (stromatica ?) paucis stratis cellularum opacarum parietibus fuscis, in parte interna in sectione longitudinali ± incoloratum, pluribus stratis cellularum applanatarum crassitunicatarum guttulatarum compositum. Canalis ostioli periphysibus hyalinis, gelatinosis, saepe in parte proximali furcatis vestitus. Peridium rostri intus textura oblita. Paraphyses numerosissimae, filiformes, prae maturitatem ascorum ± degenerantes. Asci unitunicati, basibus deliquescentibus; annulus apicalis iodo haud reagens, in sectione optica dua corpuscula refractivissima simulans. Ascosporae ± fusiformes, transverse septatae, maturae luteobrunneae, cellulis terminalibus pallidioribus, guttulatae.

Perithecia single, immersed in the substratum, blackish brown, bottle-shaped. Peridium with a conspicuous (stromatic ?) outer layer of small, dark brown cells and a thicker inner layer of ± colourless, guttulate cells which become more thick-walled towards the outside. Ostiolar channel lined with numerous hyaline periphyses, which are embedded in a gelatinous matrix and often branched at the base, diverging inward from a textura oblita in the wall of the neck. Paraphyses very numerous, filiform, ± degenerated in mature perithecia. Asci unitunicate, with a distinct, apical ring that appears as two refringent bodies in optical section and shows no reaction to iodine, but is stained deeply by Congo red. The bases of the asci deliquesce before maturity and the asci are lying loosely in the perithecial cavity. Ascospores ± fusiform, transversely septate, with pallid end cells, guttulate; primary septum median.

Herbampulla crassirostris SCHEUER & NOGRASEK spec. nov.

Earlier description: sub *Botanamphora pachycarpa* (SACC. & Él. MARCHAL) NOGRASEK & SCHEUER in NOGRASEK, Biblioth. Mycol. 133: 51 (1990) sensu NOGRASEK & SCHEUER, non SACC. & Él. MARCHAL.

Etymology: lat. *crassus* = thick
lat. *rostrum* = beak (referring to the ostiole).

Perithecia substrato immersa, solum papilla ostioli ad 200 µm longa erumpentia, solitaria, rarius paulum gregaria, globosa vel ellipsoidea, fusca, 500-650 x 240-300 µm. Papilla ostioli ad 190 µm alta. Peridium 20-28 µm crassum, in parte externa (stromatica ?) paucis stratis cellularum opacarum parietibus fuscis, in parte interna in sectione longitudinali ± incoloratum, pluribus stratis cellularum applanatarum guttulatarum compositum; extus versus cellulae parietibus crassioribus, luminibus minoribus. Canalis ostioli periphysibus hyalinis, gelatinosis, saepe in parte proximali furcatis, guttulatis vestitus; peridium rostri intus textura oblita. Paraphyses filiformes, 2-5 µm crassae, in peritheciis maturis ± degeneratae. Asci octospori, clavati-fusiformes, 80-129 x 10-12(-15) µm, numerosisimi, annulo apicali conspicuo, ca. 2.8 x 2.8 µm. Ascosporae fusiformes, 30-44(-48) x 4-6(-7,5) µm, extremis paulum rotundatis, strictae vel leniter curvatae, 5-septatae, luteobrunneae, cellulis terminalibus pallidioribus, guttulatae.

HOLOTYPUS hab. in foliis emortuis vix putrescentibus *Caricis firmae* [*Carex firma* MYGIND]: Austria, Tyrolia, in montibus 'Lechtaler Alpen' dictis, prope oppidum 'Landeck', in declivitatibus meridionalibus in vicinitate refugii 'Augsburger Hütte' supra pagum 'Grins', ca. 2200-2400 m, 09.VII.1982, leg. H. Mayrhofer (GZU).

PARATYPE MATERIAL: On dead but not very decayed leaves of *Carex firma* in the *Caricetum firmae* over calcareous substrates: AUSTRIA, Styria: Ausseer Land, Totes Gebirge, ca. 6 km N of the lake Grundlsee, Redender Stein, ca. 1900 m, 08.VIII.1982, Ch. SCHEUER. - Ennstaler Alpen, Gesäuse mountains, southern ascent to the Admonter Reichenstein, near the fountain above the Mödlinger Hütte, ca. 1700 m, 10.VIII.1985, Ch. SCHEUER. - Hochschwab mountains, Trenchtling N of Trofaiach, little peak SE of the Hochturm, ca. 2000 m, 21.IV.1985, J. HAFELLNER. - Hochschwab mountains, peak of the Großer Beilstein, NE of Aflenz, ca. 2000 m, 05.VIII.1984, J. HAFELLNER. - Hochschwab mountains, peak of the Stangenwand, NE of Aflenz, ca. 2130 m, 04.VIII.1984, J. HAFELLNER. - Eisenerzer Alpen, Reiting W of Trofaiach, NE slope of the Grieskogel, ca. 2050 m, 09.VII.1984, J. HAFELLNER & A. NOGRASEK. - Eisenerzer Alpen, Polster, ca. 1900 m, 47°32'N/14°57'40"E, 15.VI.1984, W. OBERMAYER & U. PRANTL (det. A. NOGRASEK). - On *Sesleria varia* (JAQU.) WETTST.: SWITZERLAND, Graubünden: Landwasser valley near Davos, Zügenschlucht, 1300-1350 m, 28.VIII.1980, Ch. SCHEUER (microscope slide only).

Perithecia immersed in the substratum, with a prominent, thick, erumpent beak up to 200 µm in length, single, rarely in small groups, globose or ellipsoid in outline, blackish brown, 500-650 x 240-300 µm. Peridium 20-28 µm thick, consisting of a conspicuous (stromatic ?) outer layer of small, dark

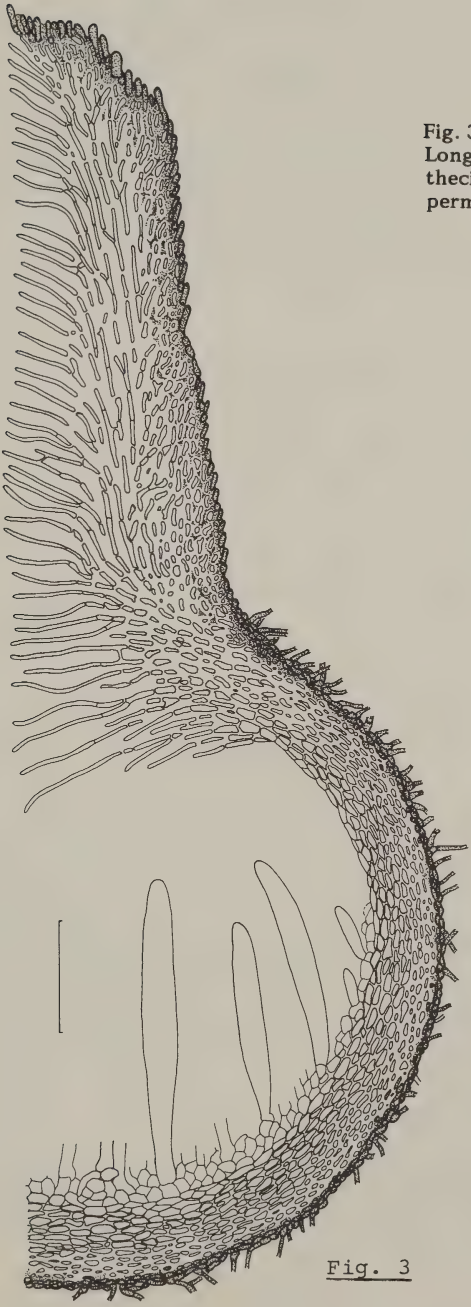

Fig. 3

Fig. 3. *Herbampulla crassirostris.* Longitudinal section of perithecium (Holotypus, lactophenol permanent slide). Bar = 50 μm.

brown cells covered with dark brown hyphae, and a thicker, well distinguishable, ± colourless inner layer of slightly larger, more flattened, guttulate cells. On the inside the cell walls are thin, towards the outside they gradually become thicker, and the lumen smaller. Ostiolar channel lined with hyaline, partly guttulate periphyses which are often forked at the base and embedded in a gelatinous matrix, diverging inward from a textura oblita in the wall of the neck. Paraphyses filiform, 2–5 µm thick, ± degenerated in mature perithecia. Asci eight-spored, fusiform, 80–129 x 10–12(–15) µm, very numerous, apical ring ca. 2.8 x 2.8 µm, staining deeply in a solution of Congo red. Croziers not seen. Ascospores fusiform, 30–44(–48) x 4–6(–7.5) µm, with slightly rounded ends, 5-septate, yellowish brown with paler end cells, guttulate (one larger oil drop in each cell).

At first, the monotypic genus *Stioclettia* DENNIS (1975: 363, with *St. luzulina* DENNIS) seemed to be quite appropriate for this peculiar fungus. But a comparison of our taxon with the type material in K proved that there are some important differences: (1) The ascus bases do not seem to dissolve before maturity, which is also suggested by the narrowly cylindrical shape of the asci with an uniseriate arrangement of ascospores. (2) The apical apparatus as figured by DENNIS (1975) and visible in the permanent microscope slides in K has a very different shape which reminds of a large *Phomatospora.* (3) The ascospores are apparently colourless, not pigmented with paler end cells. (4) The stromatic structures around the perithecia are probably more prominent in *Stioclettia*, but the type material is rather poor and the permanent microscope slides of longitudinal sections of the peridium in K do not allow any other statement. It would not have been appropriate to assign our new fungus to the wood-inhabiting, stromatic genus *Melogramma* FR. either, although there is some similarity in spore structure, and probably also in the apical apparatus of the asci and the development of the hymenium. Therefore *Herbampulla* is tentatively placed in the Melogrammataceae.

Herbampulla crassirostris and *Cainia graminis* (NIESSL) v. ARX & MÜLLER apparently prefer similar habitats and hosts. Both fungi occur on *Carex firma* and *Sesleria varia* in the *Caricetum firmae*, but also in the *Seslerio-Semperviretum* on *Sesleria varia, Cainia graminis* also on *Helictotrichon parlatorei* (WOODS) PILGER. Compared to other broad-leaved Gramineae and Cyperaceae of the Alps, these plants have rather xeromorphic leaves and prefer relatively well-drained localities – which also seems to be true for the small pyrenomycetes fruiting on their dead leaves in the early stages of decay.

Fig. 4. *Herbampulla crassirostris*: (A) Diagrammatic habit sketch of perithecia in the substrate. (B) Asci and paraphyses. (C) Ascospores (Holotypus, lactophenol permanent slides). (D) Ascospores (08.VIII.1982, Ch. SCHEUER; herbarium material in water). B–D: Bar = 20 µm.

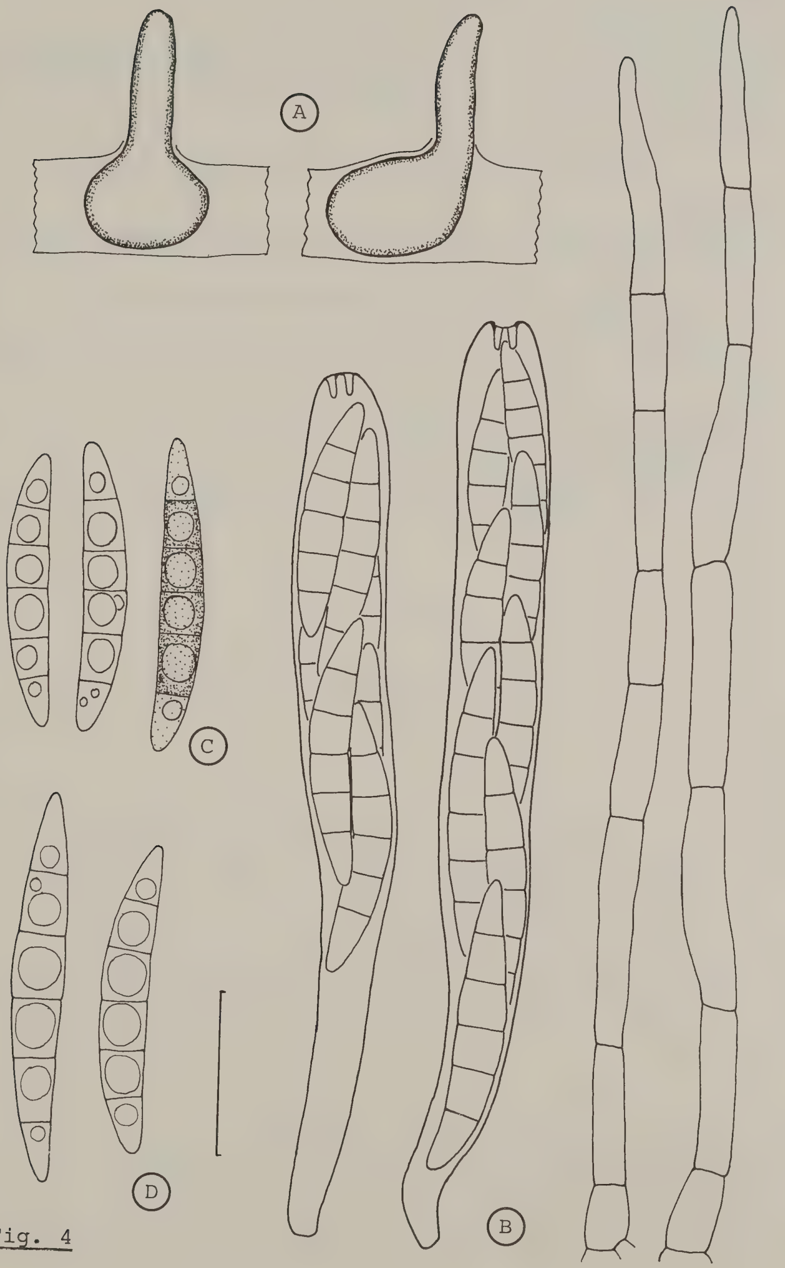

Fig. 4

Acknowledgments

Thanks are due to Dr. Dietmar KORES for drawing our attention to *Herbampulla crassirostris*, to Dr. Sergio CHIESA (Padova) for arranging the loan of the type material of *Leptosphaeria pachycarpa*, to Prof. Dr. Lennart HOLM and PD. Dr. Orlando PETRINI for acting as pre-submission reviewers.

References

BERLESE, A.N. (1894). Icones Fungorum omnium hucusque cognitorum. Vol. I. - Avellino.

DENNIS, R.W.G. (1975). New or interesting British microfungi. III. - Kew Bulletin 30: 345-365.

NOGRASEK, A. (1990). Ascomyceten auf Gefäßpflanzen der Polsterseggenrasen in den Ostalpen. - Bibliotheca Mycologica 133: 1-271 + 5 pl. - Berlin, Stuttgart: J. Cramer.

SACCARDO, P.A. (1891). Sylloge Fungorum omnium hucusque cognitorum. IX. Supplementum universale. - Padova.

SHOEMAKER, R.A. & C.E. BABCOCK (1989). *Phaeosphaeria*. - Canadian Journal of Botany 67: 1500-1599.

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NEW OR INTERESTING LICHENICOLOUS FUNGI. 3.*

KARSTENIOMYCES LLIMONAE SP. NOV. AND *SCLEROCOCCUM SERUSIAUXII* SP. NOV. (DEUTEROMYCOTINA)

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Abstract: *Karsteniomyces llimonae* Boqueras & Diederich sp. nov. (Coelomycetes) is distinguished from related species by setose pycnidia, much longer conidiophores and a different host (*Parmelina quercina*); it is known only from the type locality in Spain (Catalonia). *Sclerococcum serusiauxii* Boqueras & Diederich sp. nov. (Hyphomycetes) is distinguished by very small sporodochia, well-delimited thickened and darker regions of the conidial wall, and the host (*Parmelina pastillifera* and *P. tiliacea*); it is known from Spain (Navarra and Catalonia).

During an excursion in south Catalonia (Spain) in 1991, the authors collected an appearently undescribed species of *Karsteniomyces* growing on *Parmelina quercina*. A new species of *Sclerococcum*, growing also on species of *Parmelina*, has been discovered by the senior author in Catalonia, and by Dr E. Sérusiaux and Dr J. Etayo in Navarra (Spain). Both species are described below.

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* 2. In: *Bull. Soc. Nat. luxemb.* **93**: 155-162 (1992).

Karsteniomyces llimonae Boqueras & Diederich **sp. nov.**

Figs. (1-2).

Fungus lichenicola. Conidiomata pycnidia, singularia, dispersa, subglobosa superficialia, ostiolata, straminea ad cinnamomea, 60-120 µm diam., setis hyalinis, non-septatis, 17-27 x 4-8 µm. Conidiophora elongata, simplicia ad sparse ramosa, sparse septata, hyalina, 30-40 x 0.7-1 µm. Cellulae conidiogenae holoblasticae, monoblasticae. Conidia sicca, elongato-ellipsoidea, hyalina, 1-septata, levia, 13-17 x 2.5-3.5 µm.

Typus: Spain, Catalonia, Montsianès, La Sénia, Barranc del Retaule (Serra des Ports), BF6914-BF6915, 1000-1100 m, on *Corylus avellana*, on *Parmelina quercina*, 10 ii 1991, *M. Boqueras, P. Diederich* 9845 & *A. Gómez-Bolea* (BCC-Lich. 5224 - holotypus; herb. Diederich - isotypus).

Conidiomata pycnidial, arising singly, scattered or loosely aggregated, subglobose, superficial, with only the base entering the host tissues, ostiolate, pale yellow orange to dark red orange, 60-120 µm diam., with setae near the ostiole; setae non-septate, hyaline, with a rounded apex, often constricted in the middle, 17-27 x 4-8 µm; pycnidial wall thin, composed of pseudosclerenchymatous cells, 15-25 µm thick. *Conidiophores* arising from the inner pycnidial wall, cylindrical, elongate, sometimes branched or septate, hyaline, 30-40 µm in length, 0.7-1 µm thick. *Conidiogenous cells* arising terminally and laterally from the conidiophores, holoblastic, monoblastic, indistinguishable from the conidiophores except in the absence of septa. *Conidia* dry, elongate-ellipsoid, with rounded ends or slightly truncate at the base, hyaline, 1-septate, smooth-walled, with slightly unequal cells, 13-17 x 2.5-3.5 µm.

Etymology: The species is named in honour of Dr Xavier Llimona (Barcelona, Catalonia, Spain) for his enthusiasm and his contribution to the mycology (including lichenology) of Catalonia.

Host: *Parmelina quercina*. The fungus acts as a parasite producing poorly delimited decolorized patches on the host thallus.

Distribution: Known only from the type locality in south Catalonia (Spain).

Observations: The new fungus is easily distinguished from the two previously known species of *Karsteniomyces*, *K. peltigerae* (P. Karsten) D. Hawksw. and *K. tuberculosus* Alstrup & D. Hawksw., by the presence of hyaline setae near the ostiole, by the much longer conidiophores, and by the different host. The two other species of *Karsteniomyces* grow on *Peltigera* and both represent the anamorph of a species of *Scutula*, *S. miliaris* (Wallr.) Trevis. and *S. aggregata* (Bagl. & Car.) Rehm respectively.

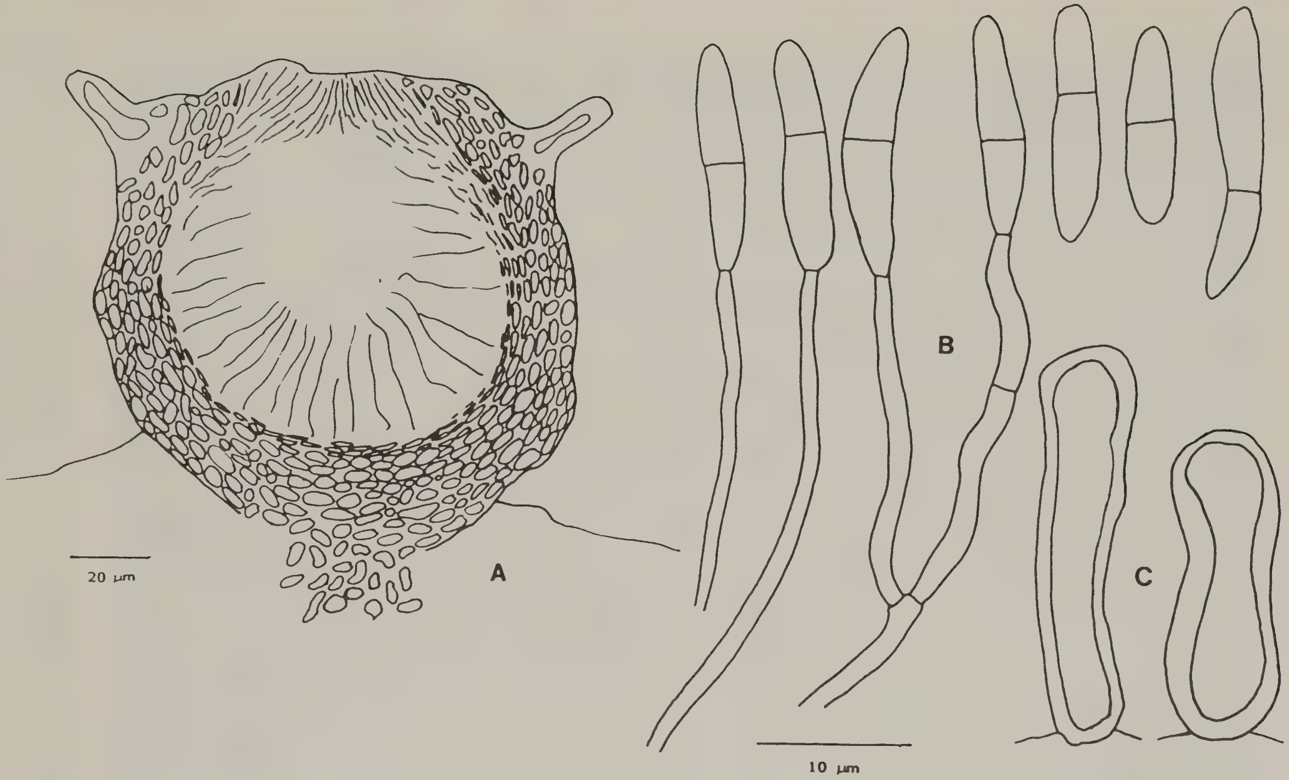


Fig. 1. - *Karsteniomyces llimonae* (herb. Diederich - isotypus): A, Section through pycnidium. B, Conidiophores and conidia. C, setae.

Because of the presence of setae near the ostiole and the much longer conidiophores, the new species perhaps belongs to a different undescribed genus. As long as no additional collections are known, we prefer, however, to include it in *Karsteniomyces.*

The thin wall of most conidiomata of the original collection collapsed, giving the conidiomata a cup-like appearance. Even with microtome sections, it was therefore difficult to present a careful description and illustrations of the inner pycnidial wall with the lower part of the conidiophores.

Sclerococcum serusiauxii Boqueras & Diederich **sp. nov.**

Figs. (3-4).

Fungus lichenicola. Conidiophora in sporodochiis densis convexis atrobrunneis, rotundatis vel elongatis, (40-)60-180(-210) x (40-)60-100(-180) µm, semi-macronemata, simplicia, atrobrunnea. Cellulae conidiogenae monoblasticae, integratae, terminales, determinatae, ellipsoideae, atrobrunneae. Conidia variabilia, in catenis irregularibus compactis, atrobrunnea, 9-20(-32) x 6-12 µm, 2-14(-20) cellulis subglobosis 3-7 µm diam., laevia, cum maculis obscurioribus.

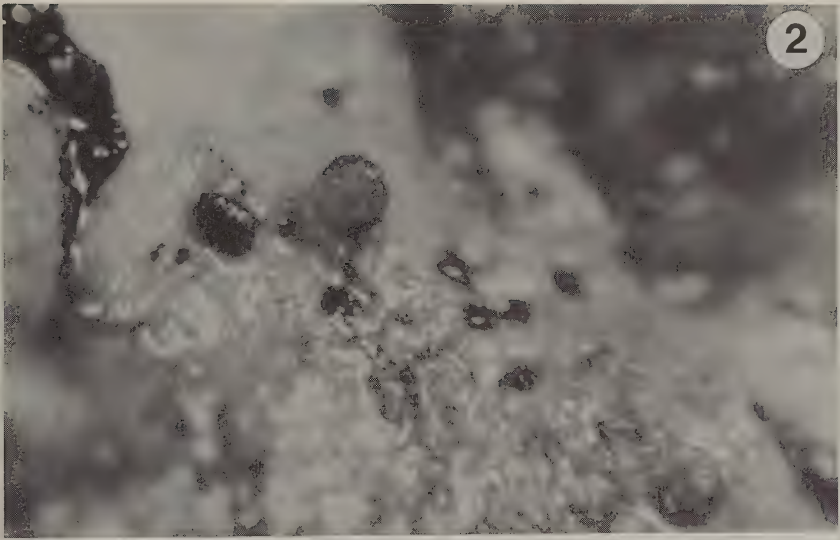
Typus: Spain, Navarra, Col de Arette-Pierre-St-Martin, Larra, alt. 1550 m, in a *Pinus uncinata* wood, on *Parmelina pastillifera*, 11 vii 1989, *E. Sérusiaux* 10604, *J. Etayo*, *P.W. James* & *F. Rose* (LG - holotypus; herb. Diederich - isotypus).

Colonies forming convex dark brown to black, rounded or rarely elongate sporodochia, (40-)60-180(-210) x (40-)60-100(-180) µm diam.; surface granular, shiny; mycelium immersed in the host thallus. *Conidiophores* semi-macronematous, not branched, agglomerated in very dense sporodochia, brown or reddish brown. *Conidiogenous cells* monoblastic, integrated, terminal, determinate, ellipsoid to globose, reddish brown. *Conidia* variable in form, produced as irregular compact chains, ellipsoid, clavate, sometimes lobed, dark brown, 9-20(-32) x 6-12 µm, composed of 2-14-(20) subspherical or irregular cells of 3-7 µm diam., with a smooth surface, cell wall unevenly thick, the thicker parts much darker than the rest of the conidium.

Etymology: The new species is named in honour of Dr Emmanuël Sérusiaux (Liège, Belgium) who collected the type specimen in the Pyrenees, and who allowed us to describe it.

Hosts: *Parmelina pastillifera* and *P. tiliacea* (thallus, absent on the isidia). The host thallus is not damaged by the presence of this fungus.

Distribution: Known from Navarra and south Catalonia (Spain).



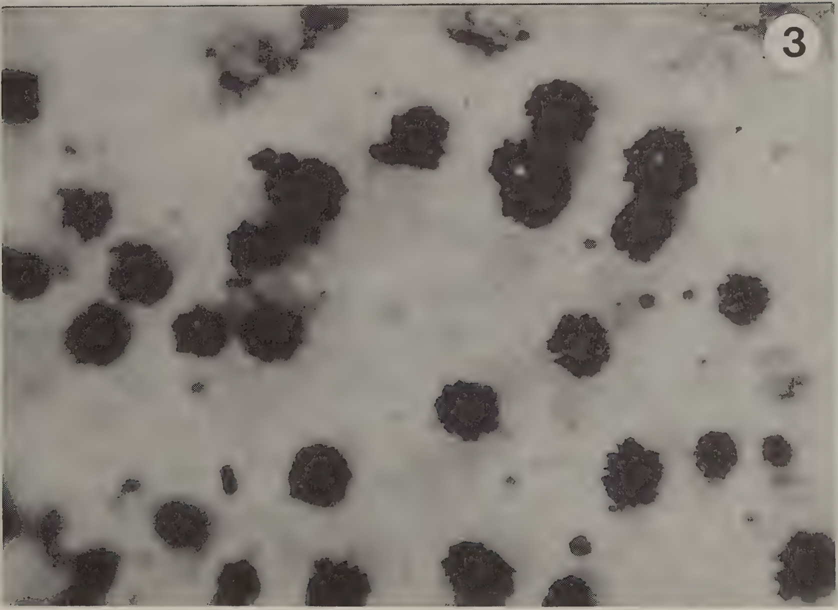


Fig. 2. - *Karsteniomyces llimonae* (herb. Diederich - isotypus): Two pycnidia on the thallus of *Parmelina quercina*; note the setae around the ostiole (x 80).

Fig. 3. - *Sclerococcum serusiauxii* (LG - holotypus): Thallus of *Parmelina pastillifera* with numerous sporodochia (x 80).

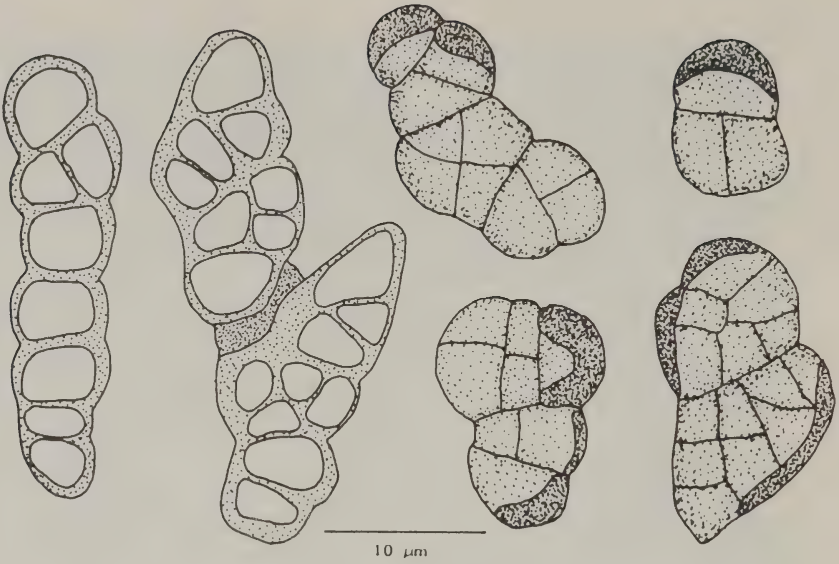


Fig. 4. - *Sclerococcum serusiauxii* (LG - holotypus): Mature conidia, the two on the left in optical section.

Observations: This species is easily distinguished from the two other known *Sclerococcum* species with multicelled conidia by the very small sporodochia (they are 170-350 µm in *S. sphaerale* (Ach.) Fr., and 225-500 µm in *S. epiphytorum* Diederich; see Diederich, 1990), by the granular surface of the sporodochia in which conidia are often grouped in erect finger-shaped processes, by the larger number of cells per conidium, and by the conidia showing irregular, well-delimited darker regions due to an unevenly thickened cell wall, similar to that known in *Milospium graphideorum* (Nyl.) D. Hawksw. (Hawksworth, 1975).

Additional specimens: Spain, Catalonia, Terra Alta, Arnes, Barranc del Grevolar (Serra des Ports), BF7125, 800-900 m, on *Juniperus oxycedrus*, on *Parmelina tiliacea*, 20 x 1990, *M. Boqueras, A. Farnós & A. Gómez-Bolea* (BCC-Lich. 5225). Spain, Navarra, Isaba, on *P. tiliacea*, s. d., Etayo s. n. (herb. Etayo).

Acknowledgements

We wish to thank Dr Emmanuël Sérusiaux (Liège) and Dr Javier Etayo (Pamplona) for placing their collections of the new *Sclerococcum* at our disposal, Mr Guy Marson (Luxembourg) for preparing microtome sections of *Karsteniomyces llimonae*, as well as Prof. David L. Hawksworth and Dr E. Sérusiaux for reading and commenting on our manuscript. The first author is obliged to the DGICYT, project nr PB89-0518-C02-01, for the financial support.

References

Diederich P. (1990) - New or interesting lichenicolous fungi. 1. Species from Luxembourg. *Mycotaxon* **37**: 297-320.

Hawksworth D. L. (1975) - A revision of lichenicolous fungi accepted by Keissler in *Coniothecium. Trans. Br. mycol. Soc.* **65**: 219-228.

Hawksworth D. L. (1981) - The lichenicolous Coelomycetes. *Bull. Br. Mus. nat. Hist. (Bot.)* **9**: 1-98.

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AMANITA REIDII - A NEW SPECIES FROM SOUTH AFRICA

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SUMMARY

Amanita reidii is described and compared with the closely related *A. phalloides* (Fr.) Link

Since the publication of the recent monograph of South African species of *Amanita* (Reid & Eicker, 1991) a further undescribed species has been found growing in open stands of *Eucalyptus*. This new taxon is recognized by its grey-brown cap, conspicuously streaked with darker radial markings and by its saccate volva. A description of the new taxon follows:

Amanita reidii Eicker & Greuning, sp. nov.

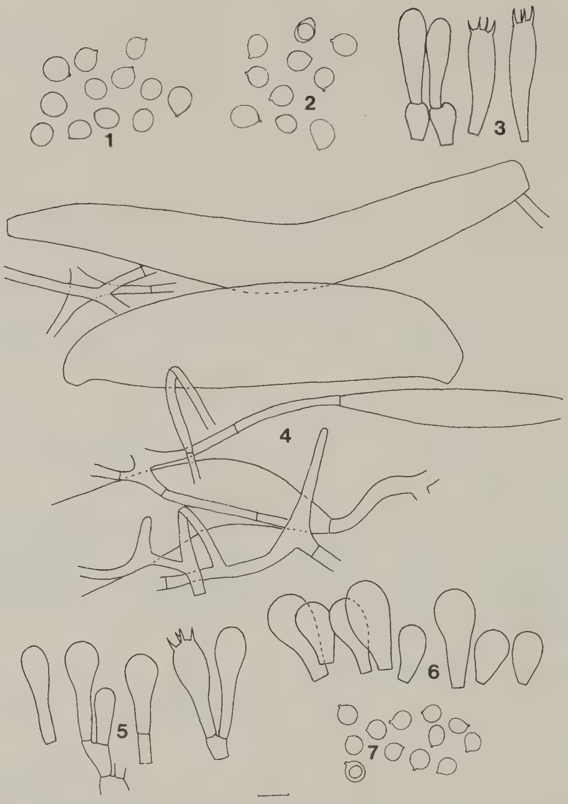
(Figs 1-8)

Etym.: *reidii* - After Dr Derek A. Reid, for his significant contribution to South African mycology

Pileus 3.0-7.2 cm diam., convexus vel applanatus, vel leviter campanulatus, fusco-griseo-brunneus, centrum alibique versus pallide maculatescens; marginem versus lineis conspicuis radialibus atrofuscis ornatus; superficies pilei glabra, sine reliquiis veli; margo pilei non striatus. *Lamellae* adnexae, fere liberae, albae. *Stipes* 3-7 cm altus, ad apicem 0.5-1.5 cm. diam., aequalis vel clavatus, basi usque 2.2 cm diam., albus vel sordide albus, annulo albo apicali membranaceo ornatus; infra annulum superficie in squamas minutas fractiflexas disrupta. *Volva* libera, alba, cylindrica ad stipitem arcte posita. *Structura volvae* hyphis angustis, usque 4 μm diam., efibulatis composita; nonnullis segmentis harum hypharum elongatis, inflatis, usque 200 μm longis et 35 μm latis. *Cheilocystidia* 20-36 X 10-16 μm, clavata vel ovata parietibus tenuibus. *Basidia* 36-50 X 7-11 μm hyalina, clavata, quadrispora parietibus tenuibus. *Sporae* subglobosae vel ovatae 7.5-8.0 X 6.0-7.2, vel ovato-ellipticae 9.0-10.0 X 6.5-8.0 μm, amyloidea, parietibus tenuibus; sporae ex pulvere sporarum 8.0-9.5 X 6.2-9.0 μm metientes.

Holotypus sub *Eucalyptus*, Hideaway Game Farm, Melkrivier, prope Pretoria, 29 April 1990; V. van Greuning & D.A. Reid. [in PRUM].

Pileus 3.0-7.2 cm convex or shallowly campanulate, becoming shallowly convex or flattened, blotchily grey brown with an innately radially streaky surface. The colour may vary to darker grey-brown or blackish slate-grey toward the centre and become paler toward the margin, although the pileus often develops pallid dirty white blotches at the disc or elsewhere. The streakiness is most conspicuous toward the outer portion of the cap where the radial, dark grey-brown streaks contrast more sharply against the pale ground colour. Pileus lacking all traces of velar tissue. *Stipe* 3-7 cm high, 0.5-1.5 cm wide at the equal or slightly enlarged



Figs 1-7. *Amanita reidii*. 1. Spores from print mounted in Melzer's solution. 2. Spores from gill mounted in Melzer's solution. 3. Basidia. 4. Elements from universal veil. All from holotype. 5. Basidia. 6. Cheilocystidia. 7. Spores from print mounted in NH_3 with congo red. All from Belfast collection. Bar = 10 μm.

apex, and up to 2.2 cm at the clavate, nonbulbous base, white to dirty white, the surface with fibrillose scaly zig-zag markings below the annulus. *Annulus* apical, pendulous, white, membranous. *Volva* white, saccate, and although free from the stipe, sheathing it rather closely. *Lamellae* adnexed to almost free, white to creamy-white. *Universal Velar tissue* lacking from surface of pileus; structure of volval limb hyphal, comprising narrow hyaline hyphae with a variable proportion of very long inflated segments, but devoid of sphaerocysts; Occasional conducting (gloeoplerous) hyphae present in some collections. The narrow hyphae, to 4 μm wide, lack clamp connexions at the septa, and have thin but rather distinct walls. The inflated segments, often fusoid, are usually of an intercalary position, up to 200 μm long, and up to 35 μm wide. *Partial veil* hyphal. *Cheilocystidia* 20-36 X 10-16 μm thin-walled, hyaline clavate or ovate. In the Bergvliet material the gill edge is formed of a thick layer of dissociating chains of thin-walled, hyaline, globose or ovate elements up to 30 μm long and to 23 μm wide. *Basidia* 36-50 X 7-11 μm, 4-spored, thin-walled. hyaline, clavate, originating from rounded or wedge-shaped segments, but lacking a basal clamp-connexion. *Spores* from print: 8.0-9.5 X 6.2-9.0 μm (measured in Melzer's solution), varying subglobose to ovate, more rarely ovate-elliptic, thin-walled, hyaline, amyloid. Spores taken from the gill more variable in size and shape : measuring 7.0-8.0 X 6.0-7.2 μm when subglobose or ovate, but 9.0-10.0 X 6.5-8.0 μm when ovate-elliptic.

Distribution: under *Eucalyptus claeziana*, Bergvliet State Forest, Sabie, G.C.A. van der Westhuizen (35), 7 Dec. 1984 [PREM 48618]; under *Eucalyptus*, Hideaway Game Farm, Melkrivier, V. van Greuning & D.A. Reid, 29 April 1990 [PRUM 3179] [Holotype]; in open situation under *Eucalyptus*, Pineglades, Belfast, 8 Feb. 1991. These gatherings are deposited in PRUM (Mycology Section of the H.G.W.J. Schweickerdt herbarium, PRU, University of Pretoria) or PREM.

Edibility nothing is known regarding the edibility of this species, but because of a suggested relationship with *A. phalloides* it should be treated with very great caution and avoided.

DISCUSSION

A. reidii is undoubtedly closely related to *A. phalloides* (Fr.) Link, differing in its prominently streaky grey-brown pileus, without trace of green tints. By contrast the pileus of *A. phalloides* is yellow-green to olive-green, ornamented with fine, innate, rather densely crowded and slightly darker radial streaks. In *A. reidii* the streaks are fewer but darker and altogether more pronounced. The white stipe of *A. reidii* also differs from that of *A. phalloides*, which is often greenish, in that it is not conspicuously bulbous as in the latter species, and is rather closely sheathed by the volva. Again *A. reidii* appears to be of slightly smaller stature. Further the known collections of *A. reidii* have all comprised fruitbodies growing in the vicinity of *Eucalyptus* trees, and it may be that this fungus will ultimately be shown to require a more specialised habitat than does *A. phalloides*.

In South Africa there has been a trend toward naming the fungus described above as *A. phalloides* f. *umbrina* Ferry - at least on field meetings. However the name has not yet appeared in the South African literature.

Through the kindness of Dr. Jan Kuthan and Dr. Herink we have received copies of Ferry's original description and comments on this taxon, from which it is clear that he regarded his forma *umbrina* as representing the ultimate stage of ageing of the familiar yellow, greenish or olive fungus. As such it does not merit taxonomic recognition. Discussing the variation of *A. phalloides*, Ferry (1911) wrote "À ces diverses variétés on pourrait ajouter une forme *umbrina* .... Ce n'est pas une variété; les diverses variétés jaune, verdâtre ou olive peuvent parvenir a ce stade, qui représenté une état plus avancé : cette teinte bistre survient avant qu'il y ait la moindre trace d'altérative ou ni la moindre odeur."

Since we have observed specimens of the fungus under discussion in all stages of development at the Melkrivier locality without finding any evidence of green tints in the young fruitbodies, we feel confident that the South African material represents an autonomous taxon distinct from both *Amanita phalloides* f. *phalloides* and *A. phalloides* f. *umbrina*. We have, therefore, decided to publish it at specific rank under the name *A. reidii*.

Reference to the publications of Bottomley and Talbot (1954) and van der Westhuizen (1983) suggest that they were aware of this brown to grey brown *Amanita*, but that they included it in their concept of *A. phalloides* (Fr.) Link. Thus Bottomley & Talbot (l.c.) in their description of the latter referred to it as having the cap "smooth or *streaked with dark innate fibrils* and to be variable in colour from "greenish, yellowish olive, greyish brown, *umber brown to smoky olive, or even darker* ....". Indeed their italics suggest that umber brown to smoky olive was the more commonly met with colour form, and further suggests that it was *A. reidii* rather than the true *A. phalloides* which was the more familiar species to these authors - at least in the Transvaal. Van der Westhuizen (1983) also noted that *A. phalloides*, in South Africa, occurred in various shades of greenish yellow olive, smoky brownish-green, umber brown to smoky olive, darker towards the centre." This description again appears to have embraced *A. reidii*.

Having considered the taxonomic relationship between *A. reidii* and the other species of *Amanita* known to occur in South Africa it is necessary to consider this relationship in a wider context. It would seem that the South African species is most closely related to *A. alauda* Corner & Bas (1962), which was described from the Gardens Jungle, Botanic Gardens, Singapore, based on a single collection comprising two half specimens. This species belongs in *Amanita*, subgenus *Lepidella*, section Phalloideae, along with both *A. phalloides* and *A. reidii*.

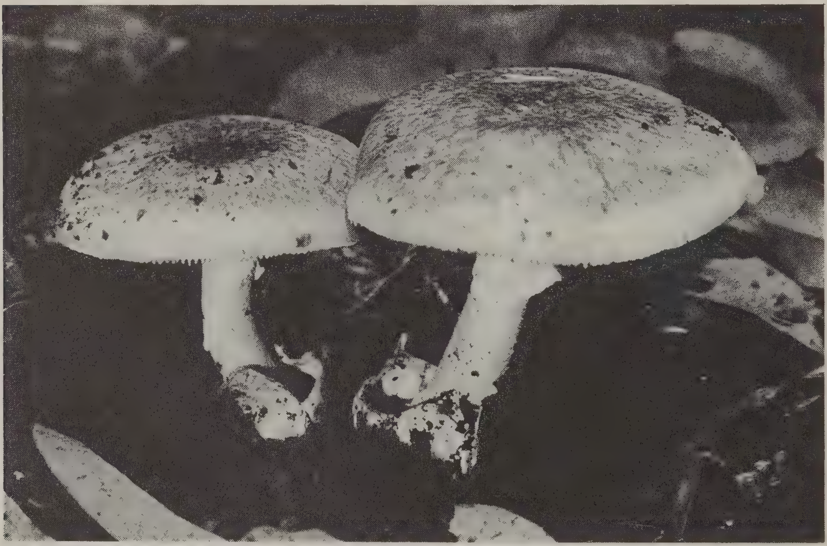


Fig. 8. Amanita reidii. *Two fruitbodies from Melkrivier collection x 1.*

A. alauda is very similar to *A. reidii* in having a brownish cap devoid of green colouration, varying from sepia or pale purplish umber to mouse-coloured, darker at the centre. More importantly the cap is "streaked by innate dark fibrils, especially near margin". However the stature of *A. alauda* differs from that of *A. reidii* in that whereas the latter tends to be rather short and squat with the length of the stem about equal to the diameter of the cap, *A. alauda* is taller and more elegant in appearance with the length of the narrow stem approaching twice the diameter of the cap.

Further the cap of *A. alauda* has a distinct umbo seated in a central depression; in contrast the cap of *A. reidii* is either shallowly campanulate with a flattened, sometimes almost truncate disc, or applanate; umbonate sporophores have not been observed in this species. Another difference is that the cap of *A. alauda* is more distinctly brown in colour, and the radial streakiness is less complete and less obviously reticulate. Further the cap surface of *A. alauda* was described as viscid, a feature emphasized in the authors discussion of their new taxon. A viscid cap cuticle has not been observed in *A. reidii*. Again the surface of the stem of *A. alaudia* was said to be smooth; in *A. reidii* it disrupts into a zig-zag pattern of fibrillose markings, but this may not be of great taxonomic significance. Spore size and shape are very similar in both taxa as are the basidial features. Cheilocystidia are also similar although these organs are very slightly broader in *A. alauda*. However comparison of the account of the microstructure of the volval limb of *A. alauda* with that of *A. reidii* suggests that there are differences in this respect. Corner & Bas (1962) wrote "Limb of volva mainly consisting of 3-5(-25) μm wide, interwoven sublongitudinal hyphae, with some scarce sphaerocysts up to 100 μm wide in the inner part". There is no mention of the occurrence of very long, rather abruptly inflated fusoid hyphal segments such as those found in the volval tissue of *A. reidii*. Finally there is the difference in habitat to be considered for while *A. reidii* appears to grow in association with *Eucalyptus*, which is suggestive of a mycorrhizal relationship, *A. alauda* was said to grow in jungle with the implication that it grew amongst native vegetation.

Finally since *A. reidii* has, to date, been found only in areas strongly influenced by human activity, it seems that this fungus will prove to be an exotic species in South Africa. If so one might look to Australasia as its possible geographical origin.

ACKNOWLEDGEMENTS

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REFERENCES

Bottomley, A.M. & Talbot, P.H.B. (1954). Common Edible and Poisonous Mushrooms in South Africa. *Bulletin 324, Botany and Plant Pathology Series No.17*, Department of Agriculture, Union of South Africa.

Corner, E.J.H. & Bas, C. (1962). The genus *Amanita* in Singapore and Malaya. *Persoonia* **2**: 241-304.

Ferry, R. (1911). Etudes sur les Amanites. *A. phalloides*, *A. verna*, *A.virosa*, *Revue mycologique*. Toulouse. Suppl. 1.

Reid, D.A. & Eicker, A. (1991). South African fungi : the genus *Amanita*. *Mycological Research* **95**, 80-95.

Van der Westhuizen, G.C.A. (1983). Mushrooms and Toadstools. *Bulletin 396. Plant Protection Research Institute, Department of Agriculture, South Africa.*

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PHYTOPHTHORA HIBERNALIS AND P. SYRINGAE

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ABSTRACT

A comparative morphological study of isolates of Phytophthora hibernalis and P. syringae confirmed that these are two distinct species, readily distinguished by the easily deciduous, elongated ovoid to ellipsoidal sporangia with long pedicels and the amphigynous and paragynous antheridia in varying proportions in the former and the nondecidous, broadly ovoid, obpyriform to ellipsoidal sporangia and the predominantly paragynous antheridia in the latter. Confusions in literature concerning these two species can be attributable to misidentification and/or acceptance of Tucker's treatment of P. hibernalis synonymous with P. syringae which had priority.

INTRODUCTION

In 1881, Berkeley first described the fungus attacking the leaves of lilac under the binomial Ovularia syringae. The pathogen was later renamed as the type of a new genus: Phloeophthora syringae Kleb. (Klebahn, 1906), then Nozemia syringae (Kleb.) Pethybr. (Pethybridge, 1913) and finally as Phytophthora syringae (Kleb.) Kleb. (Klebahn, 1909), characterized by sympodially developed sporangiophores, large "ovoid, obovoid to ellipsoidal" sporangium with a "flat cap at the end" and the production of oogonia with paragynous antheridia. Despite Sarejanni's attempt (1936) to treat it as a subvariety of *P. cactorum*, *P. syringae* has been accepted widely as a good species.

In 1925, Carne reported a new species of *Phytophthora*, *P. hibernalis* on the fruit, leaves and smaller branches of *Citrus* spp. in Australia. It was unique in its "very deciduous, ellipsoidal or lemon shaped conidia with a constant pedicel" and the production of oogonia with amphigynous and occasionally paragynous antheridia. The fungus was considered so different from *P. syringae* that Carne did not even attempt to compare these two species when he discussed the systematic position of *P. hibernalis*. However, the morphological similarity between *P. syringae* and *P. hibernalis* was noted by Petri (1927) and later by Tucker (1931) who showed that these two species were identical in the production of only paragynous antheridia on all culture media, their failure to grow at 25 C, their growth characters, the production of oogonia and oospores of almost the same dimensions, and similarly small sporangia with flattened papilla, sparse on agar medium but more abundant in water. Consequently, he concluded that *P. hibernalis* should be treated as synonymous with *P. syringae* which has priority. Leonian (1934) also found that these two species were very similar both morphologically and physiologically but he preferred to keep them as separate species, an opinion shared by Waterhouse (1963) and other researchers. However, Wager (1942), Frezzi (1950), Noviello and Snyder (1963) and Novotelnova (1974) subscribed to Tucker's thesis that *P. hibernalis* and *P. syringae* are conspecific. The dichotomy in opinions concerning the taxonomic status of these two species often led to confusion in literature, especially when both have been known to attack the same host, for example, citrus during cool weathers causing identical symptoms (Klotz and Calavan, 1969). In a comprehensive study of the sexual reproduction of _Phytophthora_ species, Savage _et al_. (1968) pointed out the urgent need for a thorough study of isolates of _P. hibernalis_ and _P. syringae_. However, most of the studies in the past centered on the pathology and ecology of _P. syringae_, especially on lilac (De Bruyn 1924a,b; 1928), apple, pear and related Rosaceae fruit trees (Harris, 1979, 85 a,b,c; Harris and Cole, 1982; Upstone, 1978; Upstone & Gunn, 1978; Doster and Bostock, 1988b; Young and Milbrath, 1959), sweet chestnut and beech (Day, 1938) and _P. hibernalis_ on citrus (Favaloro and Sammarco, 1973; Klotz, 1973).

The present study was undertaken to compare the morphological characteristics of various isolates of _P. hibernalis_ and _P. syringae_ under uniform conditions in order to define the species more precisely.

MATERIALS AND METHODS

Isolates and media: Specific information on the isolates of _P. hibernalis_ and _P. syringae_ used is given in Table 1. With the exception of N37 which was provided through the courtesy of Dr. Robert Young, Department of Plant Pathology, West Virginia University, Morgantown, Va., all isolates were obtained from the American Type Culture Collection (ATCC), Rockville, Maryland. Unless otherwise stated, clarified V-8 juice agar medium (Ribeiro, 1978) supplemented with sitosterol (30mg/l) (CV8) was used for culture.

Morphology: Colony characteristics on CV8 were compared after incubating the cultures in darkness at 20 C for 7 days. The colony diameters were measured at right angles through the inoculum, and the width of primary hyphae measured using a light microscope. Sporangia formation was induced by incubating under light at 20C small mycelial agar discs on CV8 in freshly collected stream water that had been filtered through 0.45 μm pore size membrane discs. Sex organs in single cultures were examined periodically by microsocopy through the bottom of the petri dish. If the isolate failed to produce sex organs in single culture, it was then grown on Tryptophane Medium (Ribeiro, 1978) or CV8 supplemented with 10% vegetable oil (Doster and Bostock, 1988a) and incubated at 7-8C.

RESULTS

Colony morphology

All isolates were characterized by rather slow growth rate on CV8 (4-8mm/day for P. hibernalis and 4-6mm/day for P. syringae), appressed to moderately fluffy, often showing distinct growth patterns, commonly rosette (with broad, rounded petalloid sectors) in P. hibernalis and chrysanthemum (with small, narrow, rounded petaloid sectors) in P. syringae. The hyphae were narrow, 3-5 μm wide for P. hibernalis and 3-6 μm wide for P. syringae often irregular and wavy with frequent short branches. Small spherical to oval, monilioid hyphal swellings (under 25 μm) were commonly produced by some isolates of P. syringae in water or in old cultures but not by isolates of P. hibernalis. No chlamydospores were produced by any isolate under any experimental condition.

Sporangia

All isolates produced sporangia readily in water within 24-48 hrs, except ATCC 60352 P. hibernalis and ATCC 34002 P. syringae. Isolates ATCC 56352 P. hibernalis and ATCC 14837 P. syringae also produced sporangia on agar medium though not as abundantly as in water. The sporangia of P. hibernalis were rather small (av. 29-53 x 14-22 μm), characteristically elongated ovoid to ellipsoidal, often with tapered base and the broadest part near the semi-papillate apex (L/B av. 1.8-2.4), borne terminally on unbranched or long branches of narrow (1-2 μm wide), lax sympodially branched sporangiophores and were easily deciduous, each with a long pedicel (23-73 μm). In contrast, the sporangiophores of P.

syringae were either unbranched or distinctly sympodially branched bearing non-deciduous sporangia terminally on short branches often with conspicuous basal plugs and subsporangial swellings. The semi-papillate sporangia were in general larger (av. 41-75 x 39-40 μm) with mostly rounded base and rather wide and flat apex (apical thickening 1-3 μm), ovoid to ellipsoidal in water (L/B av. 1.4-2.1) but broadly ovoid to obpyriform on agar plate (L/B 1.5). No internal proliferation of sporangiophore was observed in any isolate. Nearly all sporangia released zoospores in water through single exit pore, but most sporangia of ATCC 56352 P. hibernalis germinated directly by one or more than one germ tubes through the apex whereas ATCC 14837 P. syringae occasionally formed secondary sporangia in a chain as demonstrated by Lafferty and Pethybridge (1922) Noviello and Snyder (1963) and Edney and Chambers (1981).

Sex Organs

Most isolates produced sex organs in single cultures either readily in 2-3 wks or tardily after 2-5 months. Isolates ATCC 60352 P. hibernalis and ATCC 34002 P. syringae failed to produce them under any condition. Two isolates of P. syringae, ATCC 46886 and 64876 produced sex organs sparsely only in old cultures but more rapidly and abundantly on V8C supplemented with vegetable oil. The oogonia of both species were colorless to slightly yellowish to tawnish with the single oospore nearly filling the oogonial space, and the oospore wall averaged 1-3 μm thick. In general, the oogonia and oospores of P. hibernalis were slightly smaller than those of P. syringae (av. 33-35 μm verses 33-41 μm diam and 29-32 μm versus 30-35 μm diam).

Whereas the antheridia were distinctly predominantly paragynous in all isolates of P. syringae, they were predominantly amphigynous in isolate ATCC 64708 but variable in isolates ATCC 32995 and 56353 of P. hibernalis. The antheridia were similarly small for both species, averaging

10 x 10 μm for P. hibernalis and 11 x 10 μm for P. syringae. None of the isolates studied here produced chlamydospores.

DISCUSSION

Our study of various isolates of Phytophthora hibernalis and P. syringae confirmed Waterhouse's conclusion (1963) that these are two distinct species. There is little doubt that they have much in common, for instance, their homothallism, their low maximal temperature for growth, their narrow, wavy, irregular hyphae, small antheridia, plerotic oospores and their often rosette cultural patterns. However, P. hibernalis can be easily distinguished from P. syringae primarily by the deciduous, elongated ellipsoidal and usually smaller sporangia with a tapered base bearing a long pedicel. Most isolates of P. syringae produced well-defined sympodially branched sporangiophores with broadly ovoid to obpyriform sporangia borne on short stalks and in no instance were the sporangia deciduous. The formation of small moniliform hyphal swellings is a common feature of some P. syringae isolates. These differences were also noted by previous workers (Table 4). The antheridia of P. syringae have been described as paragynous or predominantly paragynous. Our study showed that whereas both types were present, the paragynous antheridia were undoubtedly far more common than amphigynous antheridia. On the other hand, there was much confusion regarding the antheridial configuration in P. hibernalis which has been described as amphigynous, predominantly amphigynous, paragynous or predominantly paragynous (Table 4). Gerrettson-Cornell (1989) stated that the antheridia of P. hibernalis have been reported to be predominantly amphigynous in fresh cultures but predominantly paragynous in old cultures. We have not been able to confirm this in our literature research. In fact, we noticed that in isolates ATCC 32995 and 56353 of P. hibernalis most antheridia appeared initially as paragynous but later on, amphigynous antheridia often prevailed. It is quite possible that the ratio of amphigynous and paragynous antheridia produced in culture may be variable as found in P. porri (Ho, 1983) and P. megasperma (Erwin, 1965), thus explaining the discrepancies in reports regarding the antheridial types of P. hibernalis.

The confusions in literature about the morphological characteristics of P. hibernalis and P. syringae can also be attributable, at least in some cases, to misidentification. Thus, Nadel-Schiffmann (1947) reported and described "P. hibernalis" from citrus in Palestine and this paper was listed as a major reference in the species description of P. hibernalis (Waterhouse and Waterston, 1964b). Based on the information and the photographs presented by Nadel-Schiffmann in her paper, we agree with Kouyeas and Chitzanidis (1968) that the fungus should have been identified as P. syringae. Savage (1963) studied an orange isolate of "P. hibernalis" (N37) received from Klotz in California, and found many oogonia with amphigynous antheridia on 3-month lima-bean agar slants. Brennemann (1967) re-investigated N37 along with two other isolates of "P. hibernalis" (N116 received from CMI and N252 received from CBS) and reported that they produced paragynous antheridia on hemp-seed and oatmeal agar plates. He suspected too, that these isolates might be P. syringae, but did not attempt to study them thoroughly to determine their real identity. We have been able to obtain isolate N37 and based on the sporangial characteristics, there is little doubt that it should have been assigned to P. syringae instead of P. hibernalis.

Accepting Tucker's treatment of P. hibernalis to be synonymous with P. syringae which has priority, Wager (1942), Frezzi (1950) and Verneau (1953) reported "P. syringae" on citrus even though the pathogen had all or most of the features characteristic of P. hibernalis as described by Carne (1925). Wager described the antheridia of " P. syringae" as paragynous, yet his diagram of two oogonia with attached antheridia showed one to be paragynous and the other, in all likelihood, amphigynous, resembling the amphigynous antheridia of *P. cinnamomi* and *P. parasitica* in the same figure. It is puzzling why Tucker (1931) considered *P. hibernalis* identical as *P. syringae*. He compared single lilac isolate of *P. syringae* from Baarn with single isolate of *P. hibernalis* "from Kew to Baarn" and found that both produced paragynous antheridia in all media, nearly identical oogonia and oospores and similar sporangia with flattened papillae. There was no mention of the caducity of sporangia in the isolate of "*P. hibernalis*" -- a feature seldom missed by other researchers (Table 4). It is not inconceivable that the "*P. hibernalis*" isolate that Tucker examined was actually *P. syringae*.

Once these possible sources of confusions have been identified, the differences between these two species reported in literature became apparent. Thus, the sporangia of *P. hibernalis* have been reported as easily deciduous, ellipsoidal, averaging 37 (10-75) x 18 (8-35) μm; L/B 2.1 (1.8-2.5), with long pedicels (2-80 μm), closely matching our measurements in present study: 40 (29-53) x 19 (14-22) μm and 4_B 2.2 (1.8-2-4), pedicel 23-73 μm long. In contrast, *P. syringae* produced non-deciduous, broadly ovoid, obpyriform to elongated, larger sporangia, averaging 47 (21-75) x 30 (11-42) μm, L/B 1.6 (1.2-2.3) in literature and 54 (41-75) x 32 (24-40) μm, L/B 1.8 (1.4-2.1) in our study. Both species prefer low temperature for growth, with the minimum at 0-5 C and maximum 22-27 C. The antheridia of *P. syringae* are predominantly paragynous. Those authors who reported the antheridia simply as paragynous probably had missed the amphigynous antheridia which could be rare in some isolates. On the other hand, the antheridia of *P. hibernalis* can best be described as having amphigynous and paragynous antheridia in varying proportions in view of the conflicting reports in literature and based on our observations. There is little difference in the size of sex organs between these two species based on published data. The oogonia, oospores and antheridia of P. hibernalis and P. syringae averaged, respectively, 23 (27-56) vs. 31 (18-50) μm diam, 28 (20-40) vs. 28 (17-38) μm diam and 11.5 (9-21) x 11.5 (10-15) vs. 10 (10-19.6) x 8 (7-10) μm. It is interesting to note that in our study, the oogonia and oospores of P. syringae appeared slightly larger than those of P. hibernalis, averaging respectively 37 (33-41) vs. 34 (33-35) μm diam and 33 (30-35) vs. 31 (29-32) μm diam. Our measurements of the antheridia of P. hibernalis and P. syringae showed them to be similarly small: 10 x 10 vs. 11 x 10 μm. Although both species produce petalloid colonies described commonly as "rosette" many isolates of P. syringae produced "chrysanthemum" type growth patterns, with small narrow rounded sectors. Chlamydospores are absent in P. hibernalis or P. syringae. The chain-like "chlamydospores" reported by Nadel-Schiffman (1947) for "P. hibernalis" should be interpreted as moniliod hyphal swellings for the lack of delimiting septa (Blackwell, 1949).

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LITERATURE CITED

Al-Hedarthy & Tsao 1979. Sporangium pedicel length in Phytophthora species and the consideration of its uniformity in determining sporangium caducity. Trans. Br. Mycol. Soc. 72: 1-13.

Barrachina-Tuset, J.J. 1977. Contribution al conocimiento del genero Phytophthora de Bary en Espana. Ann. Inst. Nacional de Invest. Agrarias Ser. Prot. Veg. 7: 11-106.

Bensaude, M. 1929. Note sur le Phytophthora, parasite des Citrus au Portugal. Compt. Rend. soc. Biol. 101: 982-984.

Berkeley, M.J. 1881. Lilac fungus. Gard. Chron.

16: 665.

Blackwell, E. 1949. Terminology in Phytophthora. Mycol. Pap. 30. Commonw. Mycol. Inst., Kew, Surrey, England. 24pp.

Boccas, B. and E. Laville, 1978. Les maladies a Phytophthora, des agrumes. Inst. de Recherches sur les Fruits et Agrumes. 162 pp.

Bolay, A. 1977. Phytophthora syringae - agemt d'une grave pourriture des pommes en conservation. Rev. Vitic. Arbor. Hort. 9: 161-169.

Bostock, R.M. and M.A. Doster. 1985. Association of Phytophthora syringae with pruning wound cankers of almond trees. Pl. Dis. 69: 568-571.

Brasier, C.M. and R.G. Strouts. 1978. New or unusual records of plant diseases and pest. Pl. Path. 27: 99-100.

Brenneman, J.A. 1967. Patterns of sexuality in ten species of Phytophthora. M.S. Thesis, W. Va. Univ., Morgantown, W. Va. 53 pp.

Buddenhagen, I.W. 1955. Various aspects Phytophthora cactorum collar-rot of apple trees in the Netherlands. Tijdschr. Plziekt. 61: 122-129.

Carne, W.M. 1925. A brown rot of citrus in Australia (Phytophthora hibernalis n. sp.) J. Roy. Soc., W. Australia 12: 13-41.

Chester, R.S. 1932. A comparative study of three Phytophthora diseases of Lilac and of their pathogens. J. Arnold Arboretum 13: 209-232.

Day, W.R. 1938. Root-rot of sweet chestnut and beech caused by species of Phytophthora. J. Soc. For. Gr. Brit. 12: 101-115.

De Bruyn, H.L.G. 1924a. The Phytophthora disease of lilac. Phytopathology 14: 503-517.

De Bruyn, H.L.G. 1924b. De oorzaak van het epidermisch optreden van de Phytophthora ziekte van de seringen. Tijdsch. Plziekt. 30: 113-122.

De Bruyn, H.L.G. 1928. Is ontbladering als bestrijidinswijze tegen Phytophthora z ziekte van de seringen gewenscht? Tijdsch. Pl. ziekt. 34: 233-238.

Doepel, R.F. 1966. Phytophthora species on citrus in Western Australia. Pl. Dis. Reptr. 50: 494-496.

Doster, M.A. and R.M. Bostock. 1988a. The effect of temperature and type of medium on oospore production by Phythphthora syringae. Mycologia 80: 77-81.

Doster, M.A. and R.M. Bostock. 1988b. Chemical protection of almond pruning wounds from infection by Phytophthora syringae. Pl. Dis. 72: 492-494.

Edney, K.L. and D.A. Chambers. 1981. Post-harvest treatments for the control of Phytophthora syringae storage rot of apples. Ann. appl. Biol. 97: 237-241.

Erwin, D.C. 1965. Reclassification of the causal agent of root rot of alfalfa from Phytophthora crytogea to P. megasperma. Phytopathology 55: 1139-1143.

Favaloro, M. and G. Sammarco. 1973. Ricerche sul marciume del collette e radicale degli agrumi. Specie di Phytophthora presente negli agruneti della Sicilia Orientale. Phytopath. Medit. 12: 105-107.

Fawcett, H.S. 1933. New locations for Phytophthora citrophthora and P. hibernalis on citrus. Phytopathology 23: 667-669.

Fawcett, H.S. 1936. Citrus diseases and their control. McGraw-Hill, New York. 656 p.

Frezzi, M.J. 1950. Las especies de 'Phytophthora' en la Argentina. Rev. Invest. Agric. B. Aires 4: 47-133.

Gerrettson-Cornell, L. 1989. A compendum and classification of the species of the genus Phytophthora de Bary by the canons of the traditional taxonomy. For. Comm. New South Wales Tech. Pap. 45, Sydney. 103 p.

Harris, D.C. 1979. Epidemiology of Phythophthora syringae storage rot. East Malling Res. Sta. Rept. 1978 : 93-94.

Harris, D.C. 1985a. Survival of Phytophthora syringae oospores in and on apple orchardsoil. Trans. Br. Mycol. Soc. 85: 153-187.

Harris, D.C. 1985b. Microdochium fusarioides sp. nov. from oospores of Phytophthora syringae. Trans. Br. Mycol. Soc. 84: 358-361.

Harris, D.C. 1985c. The colonization of fallen apple leaves by Phytophthora syringae in relation to inoculum levels in orchard soil. Ann. Appl. Biol. 107: 179-188.

Harris, D.C. and D.M. Cole. 1982. Germination of Phytophthora syringae oospores. Trans. Br. Mycol. Soc. 79: 527-572.

Himmelbaur, W. 1911. Zur kenntnis der Phytophthoreen. Jahrb. Hambur. Wiss. Anst. 28: 39-61.

Ho, H.H. 1983. Phytophthora porri from stored carrots in Alberta. Mycologia 75: 747-751.

Klebahn, H. 1905. Eine neue Pilzkrankheit der syringen. Centbl. Bakt. 15: 335-336.

Klebahn, H. 1909. Die neue Zweig-und Knospenkrankheit. Krankheiten des Flieders. Gebruder Borntralger, Berlin. 18-75.

Klotz, L.J. 1973. Color Handbok of Citrus Diseases. Univ. of Calif. Div. of Agr. Sc. 122 p.

Klotz, L.J. and E.C. Calavan. 1969. Gum diseases of citrus in California. Univ. of Calif. Agr. Exp. Sta. Cir. 396. 2nd. rev. 27 p.

Kouyeas, H. and A. Chitzanidis. 1968. Notes on Greek species of Phytophthora. Ann. Inst. Phytopath. Benaki, N.S. 8: 175-192.

Krober, H. 1985. Experiences with Phytophthora de Bary and Pythium Pringsheim. Bundesanst fur Land - und Forstw. (Berlin-Dahlem) 255: 1-175.

Lafferty, H.A. and G.H. Pethybridge. 1922. On a Phytophthora parasitic on apples which has both amphigynous and paragynous antheridia; and an allied species which show the same phenomenon. Proc. Roy. Dublin Soc. 17: 29-43.

Leonian, L.H. 1934. Identification of Phytophthora species. W.Va. Agric. Exp. Sta. Bull. 262. 36 pp.

McLennan, E.I. 1935. Notes on the organisms causing brown rot of citrus fruit in Victoria, Austraila (Phytophthora citrophthora (Sm. & Sm.) Leon. & P. hibernalis Carne). Proc. Roy. Soc. Victoria (N.S.) 48: 96-103.

Moniz, da Maia, R. 1925. Um nuovo Oomycete parasita de a'rvores do genero Citrus? Rev. Agron (Lisbon) Ser. 4. 1: 1-11.

Nadel-Schiffmann, M. 1947. Phytophthora hibernalis. Palestine J. Bot. Rev. Ser. 6: 148-157

Newhook, F.J., G.M. Waterhouse and D.J. Stamps. 1978. Tabular key to the species of Phytophthora de Bary. Mycol. Pap. 143. Commonw. Mycol. Inst., Kew, Surrey, England. 20 p.

Noviello, C. and W.C. Snyder. 1963. A Phytophthora disease of fennel. Phytopath. Zeitsch. 46: 139-169.

Novotel'Nova, N.S. 1974. The Genus Phytophthora. Soviet Acad. Sci. Bot. Inst. Lening. U.S.S.R. 206 p.

Ogilvie, L. 1931. A fruit rot of apples and pears due to a variety of Phytopthora syringae. Long Ashton Agr. Hort. Res. Sta. Annu. Rept. 1930: 147-150.

Peglion, V. and M. Sacchetti. 1927. Intorno alla peronospora del Lilla (Phytophthora syringae, Klebahn). Atti. R. Accad. Naz. Lincei, Rend. Cl. Sci. Fis., Mat. e Nat. 5: 696-698.

Pethybridge, G.H. 1913. On the rotting of potatoe tubers by a new species of Phytophthora having a method of sexual reproduction hitherto undescribed. Sc. Proc. R. Dubl. Soc. 13: 529-564.

Petri, L. 1927. Rasseyna del cai fitopatologia pin notevoli osservat: nel, 1926. Bol. R. Staz. Pat. Veg. 7: 1-45 pp.

Ribeiro, O.K. 1978. A Source Book of the Genus Phytophthora. J. Cramer, Vaduz, Germany. 417 p.

Rosenbaum, J. 1917. Studies of the genus Phytophthora. J. Agr. Res. 8: 233-276.

Salih, H. 1974. A Phytophthora species new for Turkey determined in citrus orchards in Adana. J. Turk. Phytopath. 3: 113-115.

Sarejanni, J.A. 1936. La pourriture du collet des Solanees cultivees et la classification du genre Phytophthora. Ann. Inst. Phytopath. Benake 2:35-52.

Savage, E.J. 1963. Sexuality in the genus Phytophthora II. Intra- and interspecific pairings. Ph.D. Thesis, W.Va. Univ., Morgantown, W.Va. 87 p.

Savage, E.J., C.W. Clayton, J.H. Hunter, J.A. Brenneman, C. Laviola and M.E. Gallegly. 1968. Homothallism, heterothallism and interspecific hybridization in the genus Phytophthora. Phytopathology 58: 1004-1021.

Schwinn, F.J. 1959. Untersuchungen zur systematik der gattung Phytophthora de Bary. Arch. Mikrobiol. 33: 223-252.

Sewell, G.W.F. and J.F. Wilson. 1964. Death of maiden apple trees caused by Phytophthora syringae Kleb. and a comparison of the pathogen with P. cactorum (L. & C.) Schroet. Ann. Appl. Biol. 53: 275-280.

Stamps, D.J., G.M. Waterhouse, F.J. Newhook and G.S. Hall. 1990. Revised tabular key to the species of Phytophthora. Mycol. Pap. 162. C.A.B. Intern. Mycol. Inst., Kew, Surrey, England. 28 p.

Tucker, C.M. 1931. Taxonomy of the genus Phytophthora de Bary. Mo. Agr. Exp. St. Res. Bull. 153. 208 p.

Upstone, M.E. 1978. Phytophthora syringae fruit rot of apples. Pl. Path. 27: 24-30.

Upstone, M.E. and E. Gunn. 1978. Rainfall and the occurrence of Phytophthora syringae fruit rot of apples in Kent 1973-75. Pl. Path. 27: 30-35.

Verneau, R. 1953. Le Phytophthora parasite degli agruni nella Campania. Nota 1. Specie osservate sui frutti. Annali Exp. Agaaria 8: 133-162.

Wager, V.A. 1942. Pythiaceous fungi on citrus. Hilgardia 14: 535-548.

Waterhouse, G.M. 1963. Key to the species of Phytophthora de Bary. Mycol. Pap. 92. Commonw. Mycol. Inst., Kew, Surrey, England. 22 p.

Waterhouse, G.M. and E.M. Blackwell. 1954. Key to the species of Phytophthora recorded in the British Isles. Mycol. Pap. 57. Commonw. Myco. Inst., Kew, Surrey, England. 9 p.

Waterhouse, G.M. and J.M. Waterston. 1964a. Phytophthora syringae. Descriptions of pathogenic fungi and bacteria 32. Commonw.

Mycol. Inst., Kew, Surrey, England. 2 p.

Waterhouse, G.M. and J.M. Waterson. 1964b. Phytophthora hibernalis. Descriptions of pathogenic fungi and bacteria 31. Commonw. Mycol. Inst., Kew, Surrey, England. 2 p.

Young, R.A. and J.A. Milbrath. 1959. A stem canker disease of fruit tree nursery stock caused by Phytophthora syringae. Phytopathology 49: 114-115. (Abstr.)

Table 1. Isolates of *Phytophthora hibernalis* and *P. syringae* used in the study

Species/Isolate	Host/Substrate	Origin	Source
P. hibernalis			
ATCC 32955	Naval orange	California	Zentmyer P647
ATCC 56353	*Citrus sinensis*	W. Australia	CMI 134760
ATCC 60352	*Citrus sinensis*	Portugal	CBS 270.31 (CMI 36906)
ATCC 64708	*Aquilegia vulgaris*	New Zealand	CBS 522.77
P. syringae			
ATCC 14837	Fennel leaf	Italy	Reichle (Noviella 67)
ATCC 16709	Pear soil	Oregon	Gallegly N 157
ATCC 34002	Lemon	California	Zentmyer & Klure - UCR P649
ATCC 46886	Apple	England	Endney 1302 CBS 132.23 (CMI 38915)
ATCC 64831	Almond	California	Coffey UCR P3012
ATCC 64876	Almond	California	Bostock F-79
N37*	Orange	California	Klotz 5644/7

ATCC: Identified by American Type Culture Collection accession number
CBS : Centraalbureau voor Schimmelcultures, Baarn, Netherlands
CMI : Commonwealth Mycological Institute, Kew, Surrey, England

* Department of Plant Pathology, West Virginia University, Morgantown, Va. Received as *P. hibernalis*.

Table 2.

Characteristics of hyphae and sporangia of _Phytophthora hibernalis_ and _P. syringae_.

Species/ Isolate	Colony	Hyphal Swellings	Sporangiophore Branching	Sporangium					
				Length (um)	Breadth (um)	L/B	Base	Caducity	Pedicel length(um)
P. hibernalis									
ATCC 32955	S	--	(1)	(b) 29 6	14 3	2.1 0.3	T	Deciduous	27-73
ATCC 56352	R	--	(1)	(b) 40 3	22 2	1.8 0.2	T	Deciduous	27-68
				(c) 53 5	22 2	2.4 0.2	T	Deciduous	23-73
ATCC 60352	S	--	(1)	No sporangium produced					
ATCC 64708	C	--	(1)	(b) 39 3	16 2	2.4 0.5	T	Deciduous	
P. syringae									
ATCC 14837	Ra	++	(2)	(b) 59 10	32 6	1.8 0.3	R	Non-deciduous	--
				(c) 59 10	37 7	1.5 0.2	R	Non-deciduous	--
ATCC 16709	R	--	(2)	(b) 51 11	24 8	2.1 3.0	R	Non-deciduous	--
ATCC 34002	C	--	(2)	(b) 43 7	26 3	1.7 0.2	R	Non-deciduous	--
ATCC 46886	C	--	(2)	(b) 41 3	39 3	1.4 0.1	R	Non-deciduous	--
ATCC 64707	U	--	(2)	(b) 52 8	25 3	2.1 0.3	R	Non-deciduous	--
ATCC 64876	C	++	(2)	(b) 52 10	31 7	1.7 0.2	R	Non-deciduous	--
N37	U	++	(2)	(b) 75 8	40 4	1.9 0.1	R	Non-deciduous	--

(a) Mean ± standard error, bases on 50 measurements
(b) Sporangia produced in water
(c) Sporangia produced on agar medium
(d) S= Stellate; R= Rosette; C= Chrysanthemium; Ra= Radiate; U= Uniform

(1) Unbranched or with very lax, long sympodial branches
(2) With sympodial branches typically short, more lax in water but close on agar medium

(T) Predominantly tapered
(R) Predominantly round

Table 3. Characteristics of sex organs of *Phytophthora hibernalis* and *P. syringae*.

Species/Isolate	Oogonium diam (um)	Oospore diam (um)	Antheridium Type	Antheridium Length(um)	Antheridium Width(um)
P. hibernalis					
ATCC 32995	34±2 [a]	31±2	A/P [b]	10±1	10±1
ATCC 56353	35±2	32±2	A/P	10±2	10±1
ATCC 60352	No sex organs produced				
ATCC 64708	33±2	29±2	A*/P	10±2	11±1
P. syringae					
ATCC 14837	41±4	35±4	A/P*	14±2	12±2
ATCC 16709	33±4	30±4	A/P*	8±2	8±2
ATCC 34002	No sex organs produced				
ATCC 46886	37±4	30±4	A/P*	10±2	8±2
ATCC 64707	39±3	35±4	A/P*	12±3	8±2
ATCC 64876	34±5	30±2	A/P*	11±2	8±2
N37	40±5	35±5	A/P*	13±2	16±3

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[a] = Mean ± Standard error, based on 50 measurements

[b] A/P = amphigynous and paragynous antheridia in varying proportions;

A* = Amphigynous antheridia predominant; P* = Paragynous antheridia predominant

Table 4. Characteristics of *Phytophthora hibernalis* and *P. syringae* recorded in literature.

Ref.	Host/ Colony[a]	Hyphal Swelling	Growth Temp(C) Min/Max	Sporangio- phore branching[b]	Sporangium				Oogonium/Oospore		Antheridium
					Length (μm)	Breadth (μm)	L/B	Caducity[c]	Diam. (μm)	Diam. (μm)	Type[d]/Lth/Wth (μm)
P. hibernalis											
Carne (1925)	Citrus/U	++(?)		Un	17-56	10-28			22-56	22-45.6	A*P
					34.9	15.5	2.3	D(2-56)	40.8	35	
					30.3	14.3	2.1				
Moniz da Maia (1925)		--			17.5-58	7.5-15				22-42.5	
Bensaude (1929)	Citrus				41	19.1	2.1	D(50)			
					30	14.4	2.1		35.17	31-32	A*P
Tucker (1931)	Citrus		<5 / 25		34.4	17.9	1.9		28.44	25.7	P
Leonian (1934)			<25								AP
McLennan (1935)	Lemon Orange				Ellipsoidal			D(long)			
Fawcett (1933,1936)	Citrus		25		10-56	10-28		D(2-56)	22-56	22-45	A*P
Wager (1942)[e]	Orange		1 / 22		36	18	2.0	D(10-25)	32	27-29	P /9-12
					37.5	20	1.9		35.2		
Frezzi (1950)[e]	*Citrus limonia*/R	--	5 / 23	Un	43.5	25	1.76	D(16-80)	32	27	AP*/10.5/10--21 15
Verneau (1953)[e]	Citrus/R	--	<24		34.4	18.2	1.9		27.6	25.4	AP*
Waterhouse (1963,1964)	R	--	<5 / 25		36	19	1.9	D(-55)	35	plerotic	A*P/12 /14
Savage (1963)	Orange										A
Doepel (1966)	R								32	28	P /10
Brenneman (1967)	Orange										P
Kouyeas & Chitz. (1968)	Orange	--	<25		35	19	2.0	D(long)	34		AP* /11 /11
			<25		40	18	2.5	D(long)			AP*

Table 4. (continued)

Klotz (1973)	Citrus				Ellipsoidal			D(long)			
Salih (1974)	Orange				37	18	2.1				
Barrach.- Tuset (1977)	Citrus sinensis		24-26		46 41	18 17	2.12 2.46	D(22-54)	31	27-30	A /9-11
Robeiro (1978)		--	<5 / 25	L	36-56	19-28		D(55)	35-56	28-32	AP /12 /10
Brasier & Strouts (1978)	Chamaecyparis lawsoniana/R		3 / 25		40	17.4	2.3	D(17.5-28.8)	29.4		A*P
Newhook et al. (1978)		--		S	Obovoid w/tapered base			D(long)	28-50	25-35	A*P
Al-Hedarthy & Tsao (1979)	Citrus							D(>20)			
Gerrettson-Cornell (1989)	R	--	<5 /25-26	Un,L	30-42	14-19	2.0	D(>20)	20-56	22-46	AP /11 /11
Stamps et al. (1990)	R	--	23-27	L	45-75			D(>50)	<30-50	20-40	A*P
P. syringae											
Klebahn (1909)	Lilac			U,S	24-75	19-42		ND	18-36	17-25	P
Himmelbaur (1911)	Lilac	++			40-75	30-42		ND		30	P
Rosenbaum (1917)		++			39.86	25.33	1.49	ND	29.50		AP*
Lafferty & Peth. (1922)	Apple			S	40	27	1.5	ND	26.4 28 27.3	24.4 25.4 25	AP*
De Bruyn (1924)	Lilac			S							
Peglion & Sacc. (1927)	Lilac				33-45	11-19				24-35	

Table 4. (continued)

Tucker (1931)	*Syringa vulgaris*		<5 / 25		24.4	19.7	1.2		28.4	25	P	
Chester (1932)	Lilac		23		20-40	15-30	1.2-1.5			31.68	AP*	
Fawcett (1936)	Citrus			S	40-75	30-42				18-36x17-25	P	
Ogilvie (1931)	Apple	++			48.8	38.5	1.7					
	Pear/U					45.4		28.3	1.6			
Nadel-Schiff.[f] (1947)	Citrus/U	++[g]	0-3/23-23.5		34.8	24.5	1.4		29.8	27.2		
					36.5	20.2	1.8		29.9	26.8		
Verneau (1953)	Citrus/C	++	0-3 / 24	S	35.3	16.3	2.1	ND	28.8	27.6	AP*	
					26-52	23-29	1.5-1.7	ND	No sex organs produced			
Waterhouse & Blackwell (1954)			25	S	45-55	35		ND	30	27	AP*	/9 /9
Buddenhagen (1955)	Apple Pear/P		>25									
Noviello & Snyder (1963)	Fennel/U	++	0 /25-26	Un,S	52	32	1.6	ND	34	30	AP*	/12.5(P)
					48	32	1.5	ND	34	29	AP*	/19.6(A)
					56	33	1.7	ND	35	31	AP*	
					72	31	2.3	ND	34	29	AP*	
Waterhouse (1963, 1964)	R	++	<5 / 23	S	57	36	1.6	ND	33	Plerotic	AP*	/10 /7
Sewell & Wilson (1964)	Apple/C	++	<5/26-28	Un	30-50	20-30	1.5 1.7		28-36			
Kouyeas & Chitz. (1968)	Lemon	++	27	S	38	31	1.3	ND	No sex organs produced			
	Mandarin	++	27		48	32	1.5	ND	No sex organs produced			
	Peach	++	27		52	35	1.4	ND	No sex organs produced			
	Apricot	++	27		39	30	1.4	ND	No sex organs produced			
	Apple	++			21-55	14-40	1.4	ND	No sex organs produced			
	Pyrus communis	++			24-66	19-35	1.7	ND	No sex organs produced			
Savage *et al.* (1968)											P	
Schwinn (1959)			<5 / 27									

Table 4. (continued)

Novotel. (1974)										28-38	AP* P	
Bolay (1977)	Apple/C	++	2 / 25		22-50	19-30		ND	33-46	31-43	P	/10 /7
Ribeiro (1978)		++	<5 / 23	S	57-75	36-42						
Upstone (1978)	Apple/P						<1.6	ND	28-50	25-35	AP*	/<10/<10
Newhook *et al.* (1978)	Citrus/R	++	25	S								
Boccas & Laville (1978)	Citrus/R		5 / 23		57	36	1.6			25-35	AP*	
Krober (1985)	*Prunus armeniaca*	++	3 / 24	Un,S	46.0	29.5	1.56	ND	31.7	28-5	AP*	
	Pyrus communis/R						2.0			30	P	
Bostock & Doster (1985)	Almond/P	++	2 / 27	S	61	31						
Garrettson-Cornell (1989)		++	5 /22-24	S	24-46	20-30	1.2-2	ND	22-33	29	AP*	
Stamps *et al.* (1990)	R	++	<23-27	S	45-75		<1.6	ND	30-50	20-40	AP*	/<10/<10

[a] U = uniform; R = rosette; C = chrysanthemum; P = petalloid

[b] Un = Unbranched; S = Sympodial with short branches; L = Sympodial with long branches

[c] D = Deciduous (Pedicel length); ND = Non-deciduous

[d] A = Amphigynous; P = Paragynous; * = Dominant type

[e] = Reported as *P. syringae* (= *P. hibernalis*)

[f] = Reported as *P. hibernalis*

[g] = Reported as chlamydospores

MYCOTAXON

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A NEW CORTINARIUS FROM SOUTHEASTERN TEXAS

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SUMMARY

INTRODUCTION

Southeastern Texas has large areas of mixed pine and hardwood forest with loblolly pine (*Pinus taeda* L.) intermixed with beech (*Fagus grandifolia* Ehrh.) and southern oaks including swamp chestnut oak (*Quercus prinus* L.), sand jack oak (*Q. virginia* v. *geminata* Sarg.), willow oak (*Q. phellos* L.), and swamp red oak (*Q. falcata* var. *pagodaefolia* Ell.). Watson (1979) describes several dominant plant communities including areas of beech-magnolia-loblolly pine forest, which is a transitional association between the wetlands and the dry uplands. It occurs in the uplands and hilly terrain interspersed with successional lakes or acid bogs "where underground water seeps to the surface". In this area Watson (1979) refers to the more advanced vegetation in old lake beds as baygalls, which consist of sweet bay (*Magnolia virginiana* L.) and gall berry holly (*Ilex opaca* Ait.) along with black gum (*Nyssa sylvatica* var. *biflora*) and red bay (*Persea barbonia*). These vegetational area are often in close proximity to each other. Within this complex plant community a rather abundant, undescribed, distinctive, bright yellow *Cortinarius* first came to the attention of David Lewis who made notes on the fresh characteristics, habit and habitat. It is especially common along the boarder of the baygall communities in the transition zone to the higher elevation referred to as the beech-magnolia-loblolly pine community. Since the baygall community has plants that are typically endomycorrhizal, an ectomycorrhizal host must be found elsewhere. David Lewis and I have observed fruitings most often in association with beech, but loblolly pine or the various oaks which are subdominant members of the beech-magnolia-loblolly pine community might also be associated.

Methods: Each collection was placed in a separate wrapper to avoid mixing material. The possible mycorrhizal hosts were recorded at the time of collection. Smell and taste were recorded for specimens at the time of collection and again in the laboratory. The color standards used included Ridgway

(1912), (the colors placed in quotes) and Kornerup and Wanscher, (1978) (the colors indicated by (3A7) which in page 3, row A and color block number 7). Microscopic examination was carried out using 3% KOH and Melzer's solution. All collections are deposited at VPI unless other wise indicated.

TAXONOMY

Cortinarius lewisii sp. nov. O.K. Miller

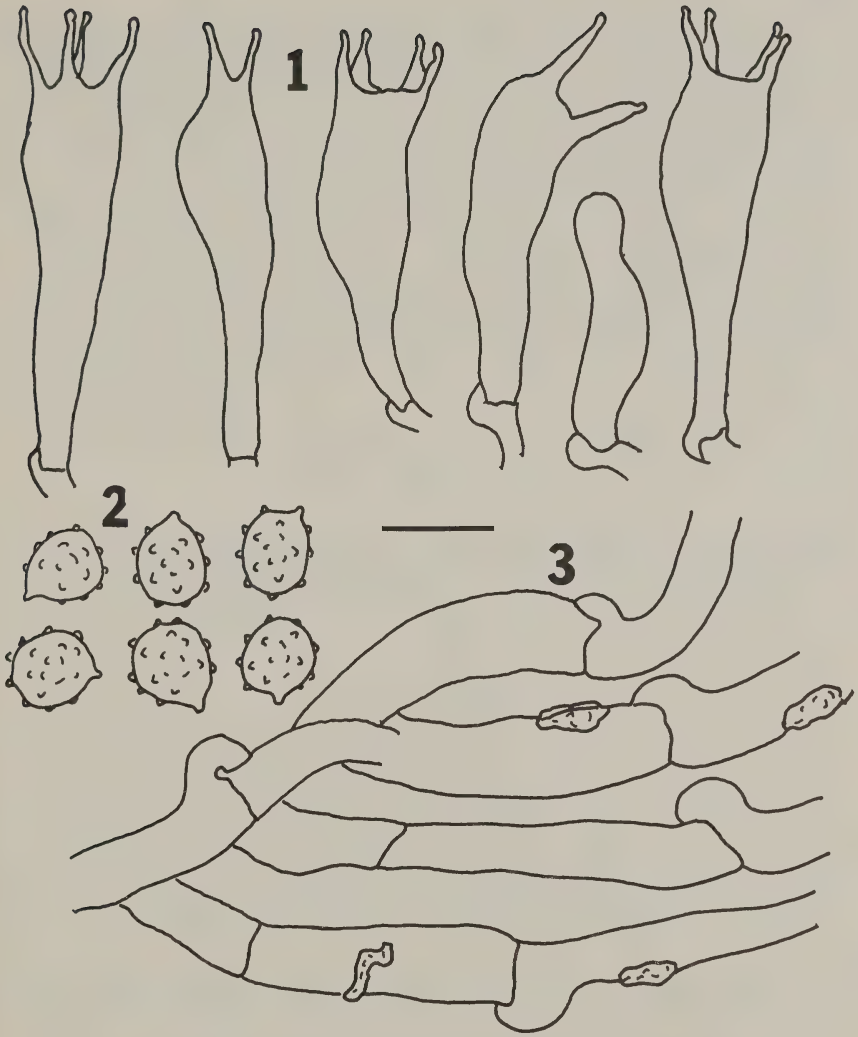
Illustrations: Texas Mushrooms p.177.

Pileus: (1-) 2-3.5 cm latus convexus, plano-convexus aut paene convexus umbone lato, squamulis aridis parvis appressis; margo incurvatus luteus aut aurantius. Lamellae adnexae aut adnatae confertae angustae seriebus duobus dispositae, in juventute albae, in maturitate aurantiacae, in vestustate ferrugineae. Stipes 4-7.5 X 0.3-0.9 (-1.1) cm latus aridus aequalis, fibrillis tenuibus juventute album, luteum in vestutate, annulo luteo prope apicem in maturitate. Odor moschatus aut raphano similis. Sapor mitis. Sporae 6-7.5 X 5-6 μm diam., subglobosae, verrucis demissis brunneis. Depositum sporatum ferrugineum. Pileipellis mixocutis est hypharum filamentosarum 3.4-8.4 um diam., fibrillis praesentibus. Trama lamellaris parallela hyalina parietibus crassiusculis.

Typum legit. D.P.Lewis-4370, 13 May 1990, Lance Rosier Unit, Big Thicket National Preserve, Hardin Co., Texas.

Pileus: (1.0-) 2-3.5 cm broad, convex, plano-convex, to nearly plane with a broad umbo in age, dry, with minutely appressed, squamules, surface bright orange-yellow "Cadmium Yellow", "Light Cadmium", margin "Apricot Yellow", buttons chrome yellow (3A5), buttercup yellow, sunflower yellow (4A8), to some cadmium orange (5A8). Margin incurved at first, plane in age. Lamellae: adnexed to narrowly adnate, close, narrow, with two tiers of lamellulae, nearly white in button to "Isabella" (2.5Y 6.5/4), "Orange-Citrine", in age becoming rusty brown from the spores. Stipe: 4-7.5 cm long, 3 - 9 (-11) mm wide, dry, equal, covered with fine fibrils, "Light Cadmium" to cream color with white mycelium over the base Partial veil: dense, cortinous, white in button but soon yellow as pileus matures, forming a bright yellow annulus near the apex but often absent at maturity. lesh: firm, "Deep Colonial Buff", to "Isabella Color". ODOR: musky to radish-musky. TASTE: mild.

Pileipellis: 80-180 μm thick, a mixocutis of filamentous hyphae 3.4-8.4 μm diam, loosely interwoven at the surface, more compact below, with scattered intracellular incrustations, occasional branching, scattered clamp connections, yellow to orange in Melzer's solution, hyaline in 3% KOH. Pileus trama: of broad hyphae 4-16 μm diam, becoming closely packed resembling a textura angularis in



Figs. 1-3. 1, 2 and 4 sp'd basidia and a basidiole. 2. basidiospores. 3. filamentous clamped hyphae of the pileipellis.
Scale bar = 10 μm.

the mid to lower trama, often with common, thick-walls (0.3-0.6 μm) and scattered clamps, hyaline in 3% KOH, yellow in Melzer's solution. Lamallar trama: parallel, thin-walled, filamentous, hyaline, hyphae 2.5-7.6 μm diam slightly thick-walled near the pileus trama, often with scattered clamp connections, hyaline in 3% KOH to light yellowish in Melzer's solution. Subhymenium: a narrow layer of thin-walled, short, filamentous, hyphae 1.7-2.5 μm diam, hyaline in 3% KOH, with scattered clamp connections. Basidia: 19-35 X 6-8 μm, clavate, laginiform, to clavate-rostrate, thin-walled, 4-spored, with infrequent 1 and 2 spored basidia, hyaline in 3%KOH and Melzer's solution. Partial veil: of filamentous, thin-walled, hyaline, hyphae 2.5-6 (-8.5) μm diam infrequently branched at right angles or Y shaped with frequent clamp connections. Universal veil not present.

Basidiospores: 6-7.5 X 5-6 μm diam, subglobose, globose, thin-walled with low, brown, warts and a small to indistinct, hyaline, apiculus, yellow-brown in 3% KOH and Melzer's solution. Spore deposit brown.

Habitat and distribution: terrestrial, common, gregarious, some subcaespitose, in mixed pine and hardwood forest or in the beech, magnolia-loblolly pine mixed forest, often near baygall communities. In Southeastern Texas. Fruiting in spring from May until June and again in October.

Material examined. United States. Texas: Orange Co.:Vidor, 23 May 1977, Lewis 974; Vidor, 5 May 1979, Lewis 1719; Vidor, 16 July 1989, Lewis 4297; Hardin Co., Lumberton, 4 Oct. 1979, Lewis 2035; Vidor, 28 May 1989; Lewis 4250; Hardin Co., Lance Rosier Unit, Big Thicket National Preserve, 13 May 1990, Lewis 4370 (Holotype); Orange Co., Sam Houston Nat. Forest, 2 Nov. 1979, O.K. Miller 18684.

Austria. Tirol: Vikartal, *Cortinarius nothosaniosus*, 9 Sept. 1951, M. Moser Nr.51/120 (holotype) (I). Sweden. Femsjo: ost Trollgol, *Cortinarius limonius*, 8 Sept. 1974, M. Moser, Nr.74/328 (I). Femsjo: Aborrasjo, *Cortinarius limoneus*, 4 Aug. 1972, M. Moser, Nr.72/159 (I).

Observations: In the baygall communities *Cortinarius lewsii* is often gregarious and numerous. The bright, orange-yellow, dry, pileus, yellow flesh, (Metzler et al 1992) and small subglobose to globose spores, and a pileipellis of interwoven hyphae are a distinctive set of characteristics which would place this species in the Subgenus *Leprocybe*,. The section *Limonei* has species with vivid yellow to yellow brown pileus coloration and globose, subglobose, to broadly elliptical, warted spores. It appears to be close to *C. nothosaniosus* Moser which is found in "versauerter Fischtenwald (*Picea abies*) mit *Vaccinium myrtillus*" in Europe, (Moser, 1966). However, *C. nothosaniosus* has a more acute umbo as illustrated by Moser (1966). In addition, the pileus is smaller (up to 2.5cm broad), the lamellae subdistant and the stipe thin and small (1.5-4cm X 2-4mm thick). Buttons are red brown with a yellowish margin which is fibrillose from the veil. Microscopic features are similar to those of C. lewisii. The basidioles of C. lewisii are variable in shape as described above and probably result from the maturation of 1, 2 and 4 spored basidia.and distinctive clusters of hyphae are present in the pileipellis with cells 8-30 μm diam. Cortinarius limonius (Fr. ex Fr.) Fr. is similar but has an "foxy red" to "orange red" pileus, is more robust than C. lewisii, and has a clavate stipe. It is a European species also found associated with spruce and pine (Moser & Julich 1986, Moser,1983).

Species that produce orellanin are found in the Subgenus Leprocybe. Testing for orellanin by Poder and Moser (1989) have revealed that the toxic species are in the Section Orellani. When tested neither C. nothosaniosus nor C. limonius, in section Limonei, contain orellanin. It is logical to conclude that C. lewisii also is unlikely to contain the toxin.

ACKNOWLEDGEMENTS

I thank David Lewis for notes and collections and the Texas Mycological Society for their hospitality. Susan and Van Metzler provided support and help. Dr Harold Burdsall and Dr. Joe Ammirati provided much appreciated comments on the manuscript. Logistical support was provided by the Virginia Museum of Natural History.

LITERATURE CITED

Fries, E. 1821 Systema Mycologica I: 213.

Metzler, S., V. Metzler, & O.K. Miller. 1992. Texas Mushrooms. Univ. of Texas Press, Austin, Texas. 350p.

Moser, M. 1966. Einige interessante Pilzfunde aus dem Gebiet von Gotschuchen. Sonderdruck aus Carinthia II, Mitteilungen des Naturwissenschaftlichen Vercines fur Karnten, 76, bzw. 156:28-30.

Moser, M. 1983. Keys to Agarics and Boleti. Gustav Fischer Verlag, Stuttgart, Germany 535 p.

Moser, M. & Julich 1986. Farbatlas der Basidiomycetes. III Agaricales. Cortinarius 3. Gustav Fischer Verlag

Kornerup, A. and J.H. Wanscher. 1966. Methuen handbook of colour. 2nd ed. Methuen & Co., Ltd., London.

Poder, R. und M. Moser. 1989. Eine einfache, empfindliche methode zum makrochemischen nachweis von orellanin. Mycologia Helvetica 3: 283-290.

Ridgway, R. 1912. Color standards and color nomenclature. Washington D.C. 44p., I-LIII Pl.

Watson, G. 1979. Big thicket Plant Ecology. 2nd Ed. Big Thicket Museum, Saratoga, Texas 10 p.

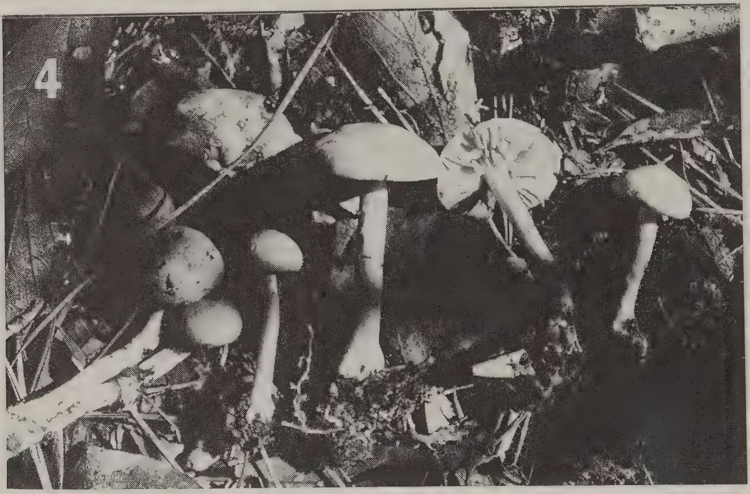


Fig. 4. *Ccrtinarius lewisii* X 1.

MYCOTAXON

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BOOK REVIEWS

L. M. Kohn, Book Review Editor

Mycota Lithuaniae Volume 5 (1): Rudieciai (Uredinales), by A. Minkevicius & M. Ignataviciute. Hardcover, 223 pp., 240 x 170 mm, 1991. Published by the Lithuanian Academy of Sciences. Requests must be sent to the Institute of Botany (Žaliųjų ežerų 47, Vilnius, 2021, Lithuania), fax 01 22 359950.

This represents the first in a series of of floristic volumes which will eventually cover all major groups of fungi known to occur in Lithuania. The present fifth volume was published out of sequence due to the advanced age of its first author, Professor Minkevicius, who has studied the Basidiomycota at the Lithuanian Academy of Sciences over the last 50 years. Although this first volume contains only line drawings, future plans for the series include color photo illustrations of macrofungi as well as detailed taxonomic descriptions of new taxa.

The current volume includes keys and descriptions to about 170 species of rust fungi from Lithuania, with data on their distribution and host biogeography. The introductory chapters also include interesting discussion on rust life history, and particularly the apparent rarity of certain life cycle stages (mostly aecial) in many species owing in part to climatic conditions in this Baltic country.

The Mycota Lithuania project was conceived and its first volume published while Lithuania was still a Soviet state. Although economic problems of a free Lithuanian state will certainly delay publication of the remaining volumes already underway, the eventuality of a complete documented mycota for Lithuania will represent a valuable contribution for understanding the biogeography of European fungi. Although this first volume is written in Lithuanian, it contains excellent summaries in both Russian and English, and most of its technical information concerning taxonomic characters and distributions should still be readable and of interest to other professional mycologists working with these fungi. *-R. Vilgalys, Department of Botany, Duke University, Durham , North Carolina 27708 U.S.A.*

Foliicolous Lichens - A Contribution to the Knowledge of the Lichen Flora of Costa Rica, Central America, by Robert Lücking. Beihefte zur Nova Hedwigia, Heft 104. VII: 1-179 + 64 figs. Softcover, 179 pp., 240 x 170, 1992. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3 A, D-7000 Stuttgart 1, Germany, fax (0711) 625001. ISBN 3-443-51026-4. DM 170.--.

The principal component of this publication are keys to all (c. 230) obligately foliicolous lichen species known from Costa Rica. Most of these have been found there for the first time by the author during his extensive investigations, including several new species published in a separate paper (Nova Hedwigia 52: 267-304). Added are very useful, good quality, black and white photographs of most species, and many line drawings of spores, asci, paraphyses, etc. Costarican localities and world distributions are provided for each species, and for most species, key, discriminative characteristics are pointed out. The short general part contains a list of collection sites and a glossary.

This book transforms Costa Rica into the country with the second largest known foliicolous lichen flora in the world. The size of this flora probably results from the varied topography of the country. It certainly also results from the poor knowledge of the lichen flora in other tropical countries.

Facultatively foliicolous lichens are poorly represented in the book. These may be recognized because they tend to also grow on adjacent twigs. They are by no means rare and are sometimes really conspicuous. Either Lücking happened not to come across them, or he omitted them, not an unusual practice. Further, a number of common neotropical taxa, like *Mazosia tumidula*, are missing; evidently these have not yet been found, or do not occur, in Costa Rica. For evident reasons the data on world distribution should be considered as provisional. The ecological rather than taxonomic background of the author is reflected in some problematical taxonomic practices. The introduction of "ad interim" names seems undesirable because they may come into wider use through the keys and lead to nomenclatoral confusion. Further, the "isotypes" do not completely reflect current use because they bear different numbers; however, they do not really deviate from the common practice of including in a single collection a number of individuals growing together. In this treatment, individuals which grew on different nearby shrubs have been given different numbers.

The main significance of this book is as an identification tool. It forms a very valuable addition to Santesson's monographic treatment of 1952, the main source of information for the group, because it treats numerous species which have been discovered since 1952, and follows the newest taxonomic rearrangements. Moreover, the numerous illustrations are a welcome complement to Santesson's sparsely illustrated book. The keys contain most of the important characters, making descriptions largely superfluous, and the illustrations capture subtle characters which are difficult to aptly convey in words.

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The Polypores of China, by Zhao Ji-Ding & Zhang Xiao-Qing. Bibliotheca Mycologica Band 145. Softcover, 524 pp., 225 x 140 mm, 1992. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3 A, D-7000 Stuttgart 1, Germany, fax (0711) 625001. ISBN 3-443-59046-2. DM 190.--.

This flora, written in English, treats 351 species. One new combination is proposed, *Phellinus quercinus* (Zhao) Zhao, and no new species are described. A short introduction is followed by a list of the Chinese polypores. There is a key to the 76 genera and keys to species appear under the treatment of each genus. The generic concepts in most cases follow Gilbertson and Ryvarden's **North American Polypores**, 1986-1987. The polypores in the major works on Chinese fungi by Tai (**Sylloge Fungorum Sinicorum**, 1979) and Teng (**Fungi from China**, 1963) have been incorporated.

The species' descriptions are original having been prepared from specimens studied by the authors. They are detailed and follow a consistent format. The principal microscopic features of 318 species are illustrated by line drawings. Each species treatment includes data on habitat, specimens examined, and distribution. The sources for the notes on habitat were probably comments accompanying the specimens, but some comments seem to be from the literature. The distribution simply lists some countries where the species has been reported. A surprisingly large number of the species, e.g., 53 of the first 100, also occur in the northern United States and Canada.

Those using this text to identify collections should be aware of a few potential problems. First, in the key to the genera each generic name appears only once. Thus, a genus having some species with and others without clamp connections, appears only once under one key choice, e.g., with clamp connections, and it will be difficult to correctly key-out those species lacking clamp connections. Second, *Meruliporia violacea* with hyaline, thin-walled spores is obviously misplaced. The prevailing concept of *Meruliporia* is of a genus with distinctly yellow-brown spores. Third, in some drawings the spore shapes differ somewhat from North American specimens, i.e., the spores are overly attenuated at the apiculus end. Fourth, the size of the spores in the drawings sometimes differs from the sizes given in the text, e.g., for *Dichomitus squalens* the text says spores 7-8 µm long but the drawing has spores 6-9.5 µm long. Finally, the spore ornamentation in *Bondarzewia montana* is correctly described as "short, irregularly arranged ridges," but the illustration shows five spores with conical to hemispherical warts.

This is an impressive volume. It is well-organized, detailed and readable, except for some instances where the choice of words is confusing. It will be an important reference in the identification of specimens from Asia. Students of the polypores will find this a useful volume, as will biogeographers, forest pathologists and plant quarantine scientists. *J. Ginns, Centre for Land and Biological Resources Research, Ottawa, Canada.*

Pilze auf Pilzfruchtkörpern. Untersuchungen zur Ökologie, Systematik und Chemie, by Wolfgang Helfer. Libri Botanici 1:1-157 + 8 color figs. Softcover, 240 x 170 mm, 1991. IHW-Verlag, Bert-Brecht-Straße. 18, D-8057 Eching, Germany, fax 089-3192257. ISBN 3-9802732-2-9. DM 88.--, US $55.--.

This initial volume of a new series concerns the fungi that occur on other fungi, sometimes referred to as the fungicolous fungi or fungicoles. The book consists of two basic sections. One section presents a taxonomic account of the 140 species of Bavarian fungicolous fungi encountered in the study including seven new species. Although primarily Ascomycetes and Fungi Imperfecti, there are 9 species in the Zygomycetes and 13 Basidiomycetes. Fungi occurring on myxomycetes are listed separately. Many of these species occur widely in temperate regions. Descriptions are included for only the newly described species with taxonomic literature for each species abundantly cited. A few taxonomic inconsistencies exist, for example, *Nectria vilior* Starb. (as *N. violor*) is listed as a synonym of *N. berkeleyana* on p. 52 while on p. 47 it is not and should not be in my estimation. But for the most part the taxonomy is accurate and up-to-date. This section combined with the list of substrates, a key to genera, and a key to the known or suspected anamorphs of *Hypomyces* make this book an extremely useful synopsis of fungicolous fungi. The key to anamorphs of *Hypomyces* is especially useful given that many *Hypomyces* are encountered only rarely as the teleomorph but may have one or two distinctive anamorphs. Results of a chemotaxonomic analysis of anamorphs of *Hypomyces* bring into question current concepts of these anamorph genera. The second section presents experimental data on factors that influence infection and host specificity of *Hypomyces chrysospermus*, a fungicolous species thought to be restricted to members of the Boletales. In one series of experiments, extracts of various host fungi are shown to affect the germination rate of aleurioconidia and phialoconidia differentially. Other experiments involve the effects of extracts of *Paxillus involutus* on aleurioconidia under various conditions. Finally, an attempt was made to isolate and identify the factor that stimulates germination of aleurioconidia. Although unsuccessful, this research is unique and fascinating with implications for related fields, for example, circumscription of the Boletales. *A. Y. Rossman, USDA-ARS Systematic Botany and Mycology Laboratory, Beltsville, Maryland 20705-2350 U.S. A.*

Ektomykorrhizien an *Fagus sylvatica*: Charakterisierung und Identifizierung, ökologische Kennzeichnung und unsterile Kultivierung, by Felix Brand. Libri Botanici 2: 1-229. Softcover, 240 x 170 mm, 1991. IHW-Verlag, Bert-Brecht Straße 18, D-8057 Eching, Germany, fax 089-3192257. ISBN 3-9802732-4-5. DM 105.--, U.S. $ 65.--.

Since the mid 1980's, Reinhard Agerer and his students have published several studies on the anatomy and morphology of various ectomycorrhizae in their well known series of publications entitled "Studies on Ectomycorrhizae" as well as in the **Colour Atlas of Ectomycorrhizae**. Now, a compilation of studies by Felix Brand is available on the ectomycorrhize of European beech.

Keys are provided for the identification of 23 distinct beech ectomycorrhizae along with their fungal symbionts. A detailed description including line drawings and black and white photographs of the morphology and anatomy is provided for each ectomycorrhiza in question. In addition, the manual contains sections on how to prepare and examine field-collected ectomycorrhizae and how to interpret the descriptions provided in the text. Detailed line drawings aid in this respect. Comparisons are made with reports of ectomycorrhizae on beech by other authors. A whole chapter provides detailed information on the edaphic factors and general ecology of the ectomycorrhizal fungi associated with beech, while another deals with the synthesis of beech ectomycorrhizae under laboratory conditions.

The specialized scope of the book may limit its usefulness. However, the detailed information presented cannot be overlooked by any researcher working on the anatomy and morphology of ectomycorrhizae found on other tree species. *L. J. Hutchison, Department of Forest Science, University of Alberta, Edmonton , Alta., Canada.*

Book Review Editor's note: MYCOTAXON has received three additional volumes in this series. Libri Botanici 3: 1-215; Allgemeine Taxonomie und Chorologie der Pflanzen, by Werner Rothmaler, a 1992 reprint of a work originally published in 1955 (ISBN 3-9802732-5-3, DM 36.--). Libri Botanici 4: 1-115 + map; Die Vegetationsentwichlung in Naßbaggerungen der bayerischen Donauebene, by Andreas Otto, 1992 (ISBN 3-9802732-7-X, DM 68.--). Libri Botanici 5:1-288 + 16 color photographs, **Pilzflora von Bayreuth und Umgebung,** by Wolfgang Beyer, 1992 (ISBN 3-9803083-1-6, DM 88.--). Note that the **Pilzflora** includes many ascomycetes (with some nice color photos) as well as basidiomycetes; Red List status is indicated for some entries.

An Illustrated Manual on Identification of some Seed-borne *Aspergilli*, *Fusaria*, *Penicillia* and their Mycotoxins, by K. Singh, J. C. Frisvad, U. Thrane, and S. B. Mathur. Softcover, 133 pp., 296 x 210 mm, 1991. Danish Government Institute of Seed Pathology for Developing Countries, P.O. Box 34, Ryvangs Allé 78, DK-2900 Hellerup, Copenhagen, Denmark. ISBN 87-7026-3175. Price outside Denmark is DKK 220.-- (excl. VAT) + postage.

This manual was written to provide a means of identifying seedborne species of *Aspergillus*, *Fusarium*, and *Penicillium*, with an emphasis on mycotoxins and other secondary metabolites as identification criteria. The book begins with information on techniques for isolating these fungi into pure culture, for growing them under standard conditions for morphological observations, and for detecting mycotoxins in culture. A compilation of information on physical characteristics of mycotoxins is provided, e.g., UV spectra, TLC data and HPLC retention indices. Descriptions illustrated with mostly color plates and line drawings are provided for 15 aspergilli, 9 fusaria, and 18 penicillia. A synoptic key is provided for species treated in each genus. The final chapter details methods for detecting and identifying mycotoxins in seeds. The book ends with a glossary of over 40 terms and a bibliography arranged by subject, with comments on some of the works cited. The authors state that they have followed the modern taxonomic and nomenclatural approach outlined in Samson and Pitt, Eds. (Plenum Press, 1990).

I find two main limitations to this manual. First, the color terminology is general and lacks reference to a standard. For example, "creamish yellow" describes the color of the reverse of a number of colonies that are shown in the plates with colors that differ significantly from each other. Additionally, for some species the color seen in the plate does not correlate with the color indicated in the description. Second, measurement data of microscopic structures are not provided, presumably because the information is available elsewhere and because this book emphasizes the use of mycotoxins for identification. This emphasis assumes a lack of variation in mycotoxin production within a species. It also requires that additional references be used to identify an isolate with certainty. For these reasons, the book is less useful as a lone identification manual, especially for users not already familiar with these organisms.

Despite these limitations, this book successfully addresses the needs of a user group that must identify species in this difficult group. The color photomicrographs are generally of high quality. The most valuable aspect of the book is the fact that it is a concise source of identification information for these three genera, especially regarding mycotoxin detection techniques. Users will find this book a worthwhile addition to their collection of identification tools. *M. E. Palm, USDA/APHIS, Systematic Botany and Mycology Laboratory, Beltsville, Maryland 20705-2350 U.S.A.*

Pleurotus unter Steß. Ökophysiologische Untersuchungen zu Wasserhaushalt und Sporulation, by Angelika Achhammer. Bibliotheca Mycologica Band 141. Softcover, 206 pp., 225 x 140 mm, 1992. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3 A, D-7000 Stuttgart, Germany, fax (0711) 625001. ISBN 3-443-59042-X. DM 130.--.

This doctoral thesis reports on the role of water relations in vegetative growth, fruiting, and sporulation of several isolates of *Pleurotus ostreatus* and one of *P. pulmonarius*. Emphasis is on the response to water stress induced either directly or indirectly. Long term and daily sporulation patterns were determined in the field and under various combinations of controlled temperature, humidity and duration of daylight and darkness.

Water loss, uptake, and transport were studied with detached fruitbodies taking into account differences among major fruitbody regions. Although sporulation continued despite considerable dehydration, even very high relative humidity could not revive dry fruitbodies. Liquid water was needed for resumption of sporulation, and to be effective had to be supplied through the cap because water movement through the stipe was generally too slow. Total water and osmotic potentials of fruitbodies were determined, and the effects of drying and freezing were studied by scanning electron microscopy of different fruitbody regions, especially the hymenium. Vitality was tested with fluorescein diacetate. Tolerance of osmotic stress was studied for mycelial growth, fruiting, sporulation and spore germination in cultures grown on media with added osmotica (NaCl and for some tests glycerol). The content of trehalose and several polyols was determined in fruitbodies subjected to osmotic stress and freezing because these compounds may protect against water stress.

The book will interest researchers studying the physiology of water relations and ecology of Hymenomycetes. It will also interest *Pleurotus* growers and forest pathologists. There is a three-page summary in English and an extensive bibliography. Few typographical errors were noted. Unfortunately, readability suffers from the fact that the results are subdivided into many sections each with introductory remarks, literature review and a lengthy discussion. In consequence it is difficult to focus on the results and to get a clear overview of the material. The problem is increased by the large number of abbreviations and the excessively complex numbering of the figures.
H. E. Gruen, Department of Biology, University of Saskatchewan, Saskatoon, Sask., Canada.

Texas Mushrooms: A Field Guide, by Susan Metzler and Van Metzler; Scientific Advisor, Orson K. Miller, Jr. Hard or Softcover, 304 pp. with 249 color photographs, 5.75 x 8.25 inches, 1992. University of Texas Press, P.O Box 7819, Austin, Texas 78713-7819. ISBN (cloth hardcover) 0-292-75125-7, U.S $39.--; ISBN (paper softcover) 0-292-75126-5, U.S. $17.95.

The authors describe their book, **Texas Mushrooms**, as a pictorial guide for beginners to common Texas mushrooms and fungi. It contains 222 major entries, each with at least one color photograph. Nearly 40% of the descriptive part of this book covers just the boletes, *Amanita*, *Lactarius*, and *Russula*. Several of the taxa included here cannot be found illustrated in other field guides. Many of the photographs are quite striking and the book is well bound and printed on good paper. Also, this is the first mushroom field guide of Texas. In fact, despite its short-comings, some particular to this book, some common to the field guide genre, **Texas Mushrooms** is a welcome addition to the growing literature of regional guides, and can give residents and non-residents alike a sense of this particular geographically defined mycoflora that is unavailable from any of the national field guides.

The book is divided into five parts: and introduction to mushroom hunting in Texas; how to use the book to identify mushrooms (illustrations, charts, etc.); a section on mushroom toxins by Robert Harvey, M.D.; a section on cooking and eating wild mushrooms (with 10 recipes); and the bulk of the book, some 271 pages, with text and accompanying photographs on the same page. There is a short list of books for further study and an index. There is also an appendix of spore data, despite the authors' stated preference for choosing "species that can be clearly distinguished by field characteristics," and their statement that "when (microscopic) examination is the only way to distinguish between closely related species, (they) provided the name of the most commonly found form" (p. 3).

Because field guides are part of taxonomic literature but are not scientific literature (usually no voucher collections are cited, etc.), the most pressing question becomes: what is an acceptable level of imprecision, and for whom? **Texas Mushrooms** lacks authors' citations, specific references to technical descriptions with each major entry, and voucher collections. Nowhere does it state that all the photographs were even taken in Texas, and, despite this guide's reliance on the photography for species determinations, some of the photos are not diagnostic, or they are murky, or badly off-color, or misdetermined. The species descriptions are less than adequate, and they are wrong in detail for some entries and neglect essential field characters of others. In fact, many species descriptions seem intended to cover whole complexes or even genera rather than species. There are also examples of the same species represented by different entries (different names and photographs). The section (and scattered notes) on mushroom poisoning is badly misleading and in error in several instances. *G. Lincoff, The New York Botanical Garden, Bronx, New York, U.S.A.*

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NOTICE: A NEW COMPUTER PROGRAM FOR THE IDENTIFICATION OF LICHEN SUBSTANCES

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Abstract: A program for the identification of lichen substances based on TLC RF values, HPLC RI-values, colours of developed spots under visible and UV light, as well as the results of lichen spot tests has been developed for Microsoft WINDOWS. The program is based on a similar program for Apple Macintosh computers. It accepts RF values from six standard solvents, a RI-value from a gradient HPLC with reverse phase column and a range of possible colours for an unlimited number of TLC spots and will generate answers within a user defined error range. A list of synonyms of lichen substances is included as well as an RF and RI-value calculator.

Introduction

Chemical investigations of lichens form an integral part of all serious taxonomic studies on lichen-forming fungi today. About 550 lichen substances are known, most of them specific to lichens. The significance of chemical characters in the taxonomy and systematics of lichenized fungi has often been discussed (W. CULBERSON 1970, 1986, C. CULBERSON 1986, CULBERSON & CULBERSON 1970, HAWKSWORTH 1976, BRODO 1978, 1986, EGAN 1986). However, even the more experienced lichenologist encouters TLC spots or HPLC peaks that are unfamiliar and difficult to identify. Lists of RF-values in standardized TLC solvent systems (CULBERSON & KRISTINSSON 1970, CULBERSON 1972, CULBERSON, & AMMANN 1979, ELIX et al. 1987b) and RI-values of gradient elution HPLC (FEIGE et al. 1993) have been published. These lists, however, cannot be kept current since new substances are continuing to be discovered and a large bulk of scattered literature exists on the RF-values of recently described substances. Associated information such as the colour of the spots, mass spectra data etc. is not available in lists, but is scattered within the literature. In an effort to make the information more readily accessible, and to keep such a library of information current as more and more lichen metabolites are identified and characterised, a data bank suitable for storing such information was developed by ELIX et al. (1987a, 1988) for APPLE MACINTOSH computers.

Discussion

In the past it has been very difficult to produce a user-friendly menu environment in the DOS system. However, with the improvement in personal computers and the introduction of the WINDOWS system this situation has changed. Moreover powerful computer equipment is now available at reasonable prices.

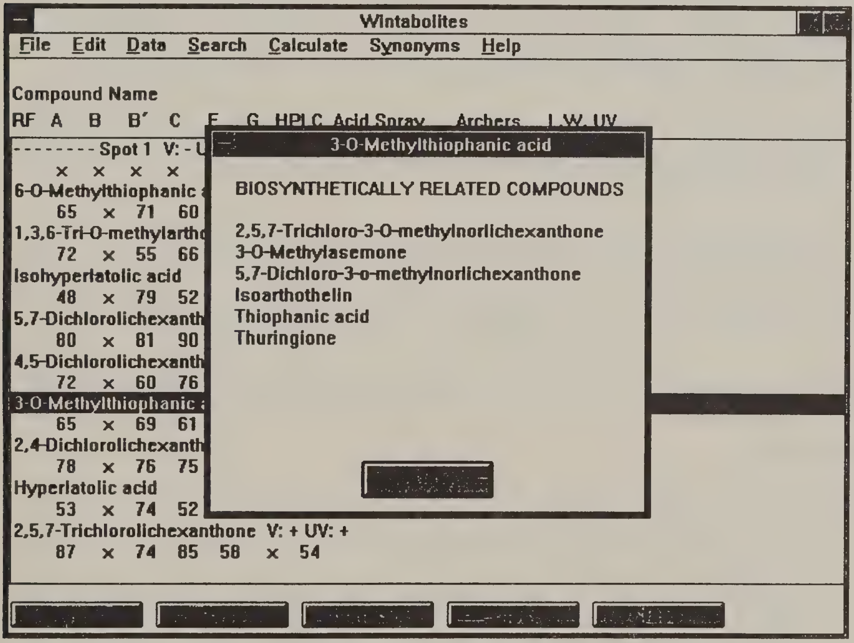
The design of the menu environment and windows of the new program resembles that of the MACTABOLITES program, but three further options were added (MIETZSCH et al. 1992). These are a "Calculate" menu to calculate RF- and RI-values, "Synonyms", which gives a list of synonyms and the appropriate names in current use and a "Help" menu. The substance classes and the HPLC RI-values are additional features of WINTABOLITES. The program makes full use of the user friendliness of the WINDOWS system as illustrated in Figure 1. The program accepts RF-data from six standard solvents, an RI-value for a gradient HPLC with reverse phase column and a range of possible colours for an unlimited number of TLC spots. A list of possible answers is generated within a user defined error range of RF/RI-values and colours.

The data set operates primarily on RF-values obtained by TLC on silica gel in any number of six standard solvent systems as well as the gradient HPLC system. Thus listed along with the name of each lichen substance is the following information:

1. The TLC RF-values of the compound in six standard solvent systems:
    A, toluene/ dioxane/ acetic acid (180 : 45 : 5)
    B, hexane/ diethyl ether/ formic acid (130 : 80 : 20)
    B', hexane/ methyl tert-butyl ether/ formic acid (140 : 72 : 18)
    C, toluene/ acetic acid (170 : 30)
    E, cyclohexane/ ethyl acetate (75 : 25)
    G, toluene/ ethyl acetate/ formic acid (139 : 83 : 8)
2. The HPLC RI-value from the gradient system described by FEIGE et al. (1993) for phenolic compounds.
3. Whether the TLC spot is coloured in visible (natural) light and/or detectable in

short wavelength ultraviolet light.

4. The colours of the TLC spot in both visible (natural) and long wave length ultraviolet light after spraying with H2SO4 and charring.
5. The colour of the TLC spot after spraying with Archers solution.
6. The results of medullary spot tests with K, C, KC, PD (when a compound gives a K + or C + reaction then KC has been omitted unless a different colour is produced by KC).
7. Three major peaks in the mass spectrum plus molecular ion (if observed).
8. The substance class.



```
Compound Name
RF  A   B   B'  C   E   G  HPLC  Acid Spray   Archers   L.W. UV
--------- Spot 1  V: - U
    ×   ×   ×   ×
6-O-Methylthiophanic a
    65  ×   71  60
1,3,6-Tri-O-methylartho
    72  ×   55  66
Isohyperlatolic acid
    48  ×   79  52
5,7-Dichlorolichexanth
    80  ×   81  90
4,5-Dichlorolichexanth
    72  ×   60  76
3-O-Methylthiophanic a
    65  ×   69  61
2,4-Dichlorolichexanth
    78  ×   76  75
Hyperlatolic acid
    53  ×   74  52
2,5,7-Trichlorolichexanthone  V: + UV: +
    87  ×   74  85  58  ×  54
```

```
3-O-Methylthiophanic acid

BIOSYNTHETICALLY RELATED COMPOUNDS

2,5,7-Trichloro-3-O-methylnorlichexanthone
3-O-Methylasemone
5,7-Dichloro-3-o-methylnorlichexanthone
Isoarthothelin
Thiophanic acid
Thuringione
```

Fig. 1: WINTABOLITES - Compounds Biosynthetically Related to 3-*O*-Methylthiophanic acid; Screen Display.

9. Up to nine biosynthetically related compounds.
10. Notes, a one hundred character long message containing additional information regarding the characteristics of the particular substance.

However, it is not necessary to have **all** such information about an unknown spot - the search program will operate on as little information as a single RF or RI-value. Qualifying information simply reduces the number of possible answers generated.

The program was written in TURBO PASCAL for WINDOWS (Borland) using object-oriented programming techniques. The size of the source code is 66 KB. As all data are kept in the main memory by using dynamic data structures during the running of the program, a very high speed of retrieval is achieved. After the program has started, the data are loaded from the data file and all records are sorted into a binary tree which ensures quick access to the data (WIRTH 1983). At the same time seven arrays are build up, there being a separate array for each solvent system and one for the HPLC. The arrays are indexed by the RF-value or the RI-value of the compounds and the elements of the arrays each contain a dynamic list of pointers to all the records which have an RF or RI of that value for that solvent. When a search is started all the lists in the array of the first solvent system from RF - error index to RF + error index of the first spot are checked and all records, where the additional information given in agreement, are regarded as possible answers. The number of data sets as well as the number of spots to be examined is unlimited.

WINTABOLITES is a WINDOWS application. Its use requires WINDOWS 3.0 or 3.1. the computer must have a 80286 or higher (i.e. 80386 or 80486) CPU and at least 2 MB RAM. A VGA graphic card and monitor is recommended.

Availibility of the program: The program and an illustrated manual are available from the German authors for a price of US $ 149. Private persons not attached to an institution may ask for a reduced price of US $ 79. Updates will be distributed to the WINTABOLITES users yearly for DM 10 to 15,- if they wish to receive them.

We wish to thank Dr. Siegfried Huneck (Halle) who kindly reviewed this manuscript.

References

BRODO, I.M. (1978): Changing concepts regarding chemical diversity in lichens. *Lichenologist* **10:** 1-11.

BRODO, I.M. (1986): Interpreting chemical variation in lichens for systematic purposes. *Bryologist* **89:** 132-138.

CULBERSON, C.F. (1972): Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromatogr.* **72:** 113-125.

CULBERSON, C.F. (1986): Biogenetic relationships of the lichen substances in the framework of systematics. *Bryologist* **89:** 91-98.

CULBERSON, C.F. & K. AMMANN (1979): Standardmethode zur Dünnschichtchromatographie von Flechtensubstanzen. *Herzogia* **5:** 1-24.

CULBERSON, C.F. & H.D. KRISTINSSON (1970): A standardized method for the identification of lichen products. *J. Chromatogr.* **46:** 85-93.

CULBERSON, W.L. (1970): Chemosystematics and ecology of lichen-forming fungi. *Ann. Rev. Ecol. Syst.* **1:** 153-170.

CULBERSON, W.L. (1986): Chemistry and sibling speciation in the lichen-forming fungi: ecological and biological considerations. *Bryologist* **89:** 123-131.

CULBERSON, W.L. & C.F. CULBERSON (1970): A phylogenetic view of the chemical evolution in the lichens. *Bryologist* **73:** 1-31.

EGAN, R.S. (1986): Correlations and non-correlations of chemical variation patterns with lichen morphology and geography. *Bryologist* **89:** 99-110.

ELIX, J. A., JOHNSTON, J., and PARKER, J. L. (1987a): *Mactabolites. Users Manual*. 2nd ed. Canberra.

ELIX, J.A., J. JOHNSTON & J.L. PARKER (1987b): *A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances.* Australian National University, Canberra.

ELIX, J.A., J. JOHNSTON & J.L. PARKER (1988): A computer program for the rapid identification of lichen substances. *Mycotaxon* **31:** 89-99.

FEIGE, G.B., LUMBSCH, H.T., HUNECK, S. & ELIX, J.A. (1992): A method for the identification of aromatic lichen substances by gradient high performance liquid chromatography. *J. Chromatogr.*, in prep.

HAWKSWORTH, D.L. (1976): *Lichen Chemotaxonomy.* S. 139-184. In: D.H. BROWN, D.L. HAWKSWORTH & R.H. BAILEY (Hrsg.): "Lichenology: Progress and Problems", Academic Press, London.

MIETZSCH, E., H.T. LUMBSCH & J.A. ELIX (1992): *Wintabolites (Mactabolites for Windows) Users Manual.* Universität Essen.

WIRTH, N. (1983): *Algorithmen und Datenstrukturen.* 3rd. edn. Stuttgart, Teubner Verlag.

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